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POWER PLANT OF THE McCORMICK BUILDING

REQUIREMENTS OF AN ISOLATED plant in an office building are severe in that the plant must compete with large central stations which are equipped with every labor saving device and apparatus designed to increase efficiency known to the field. It is usually located in the basement or sub-basement of the building where space is limited, all light artificial, and air used for combustion in the furnace must be supplied by artificial means. All these limiting conditions are present in

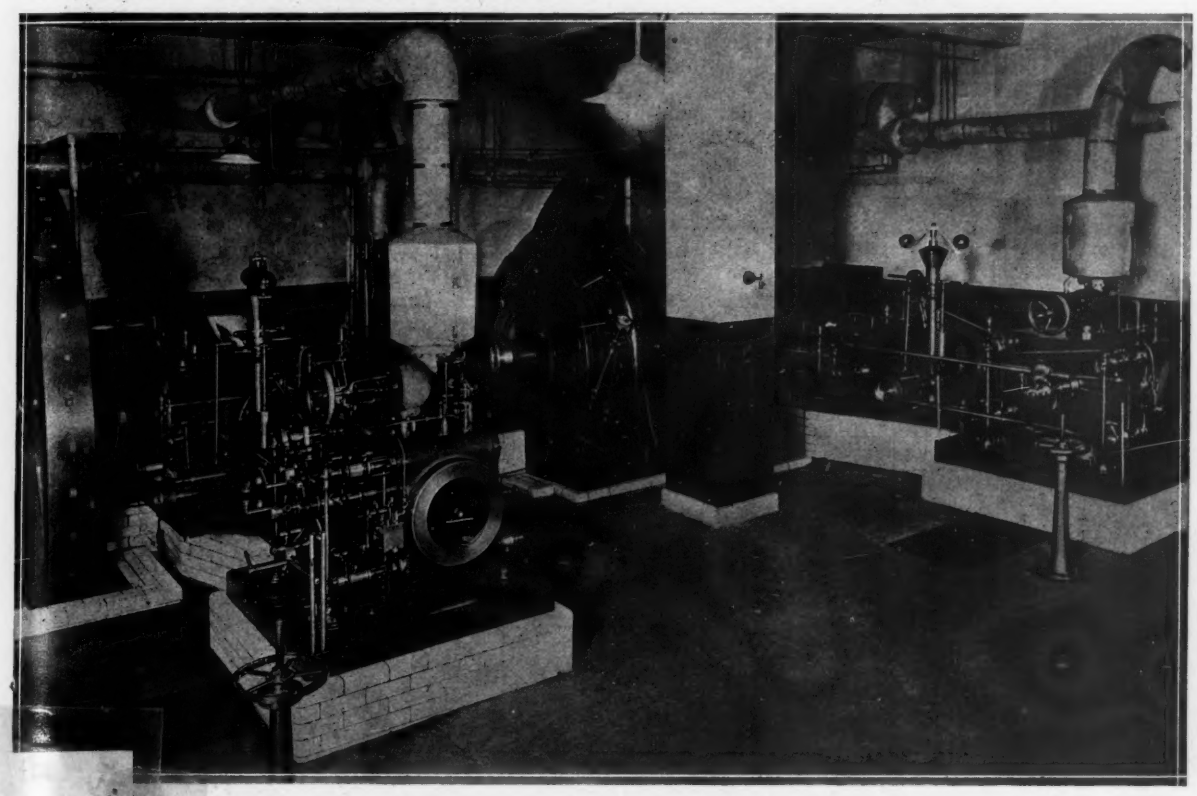


FIG. 1. GENERATING UNITS IN THE M'CORMICK BUILDING

lant of the McCormick Building, located at f Michigan Ave. and Van Buren St., in Chi-

ding is a 20-story structure with 3 basements reet level. It is strictly modern in all of its conveniences and is equipped with 9 passenger and 2 freight elevators, power for which is supplied by the plant in the second and third basements of the building. Aside from the elevator service, the plant is required to furnish light, heat, and water for all parts of the building.

Boiler Room

THE boiler room is located upon the third basement level at the north and west corner of the building. It occupies a floor space of 45 by 55 ft. and is 25 ft. high, thus extending to the floor of the first basement.

Three Heine water-tube boilers constitute the steam battery, each with a rating of 300 hp., and having 2 drums each 20 ft. long and 36 in. in diameter. The water tubes are 171 in number and 3½ in. in diameter.

Construction of these boilers is very substantial and

has a number of interesting features which have been brought out during years of experience and experiment by the Heine Safety Boiler Co. The drums are of the best boiler steel with double strap butt joints in the

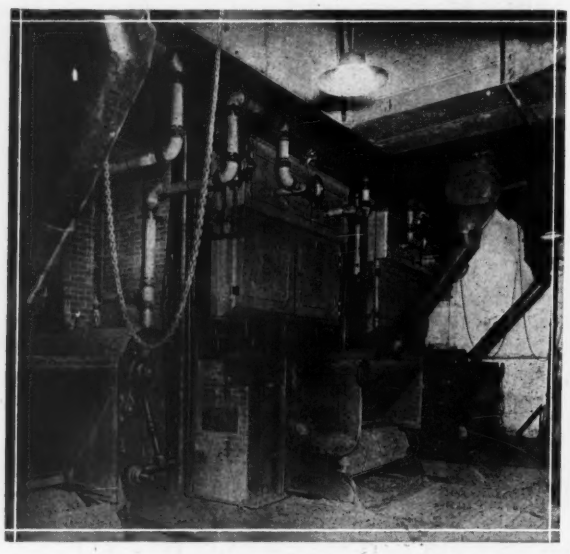


FIG. 2. VIEW IN THE BOILER ROOM OF THE M'CORMICK BUILDING

longitudinal seams where the greatest strain is placed upon the boiler shell, and girth seams lapped and double riveted.

Heads of the drums are dished to a radius equal to their diameter and machine finished so that a perfect joint is secured even before the heads are riveted on. In the rear head is placed a manhole, flanged in and reenforced, fitted with a light and stiff pressed steel cover and yoke, thus giving easy access to the interior of the boiler for inspection and cleaning.

The main steam outlet is near the front and is surrounded by a pressed steel saddle riveted to the drum for the steam tee attachment. To compensate for the material taken out of the plate at the throat opening to the waterlegs, forged steel throat stays are provided, being riveted across the throat when the water legs are attached.

A distinctive feature of this boiler is the provision of a mud drum, inside the main drum near the bottom and

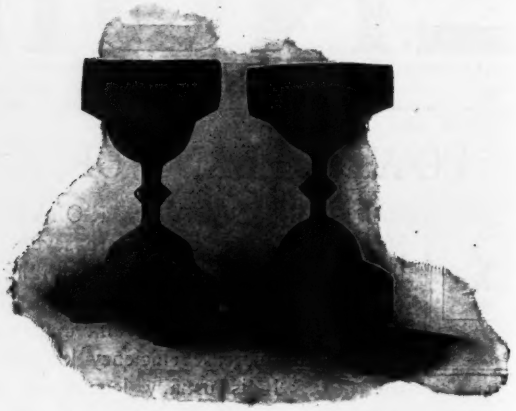


FIG. 5. THROAT STAYS USED IN HEINE BOILERS

parallel to it, into which all feed water is pumped before it is allowed to come in contact with the boiler proper. The feed-water pipe is attached to the front end of this drum and at the rear the blowoff pipe is connected, from which place it is run through the rear boiler head. The cold water entering the mud drum is heated by contact with the hot water of the boiler and then discharged through an opening in the front of the mud drum, leaving behind all precipitates and sediment which are deposited before the water is turned into steam. Another blowoff pipe is also provided which is attached to the rear waterleg, near the bottom where such sediment as may have been carried through the mud drum settles before passing to the water tubes.

In this installation Homestead Straightway blow valves are used and the pipes are further provided

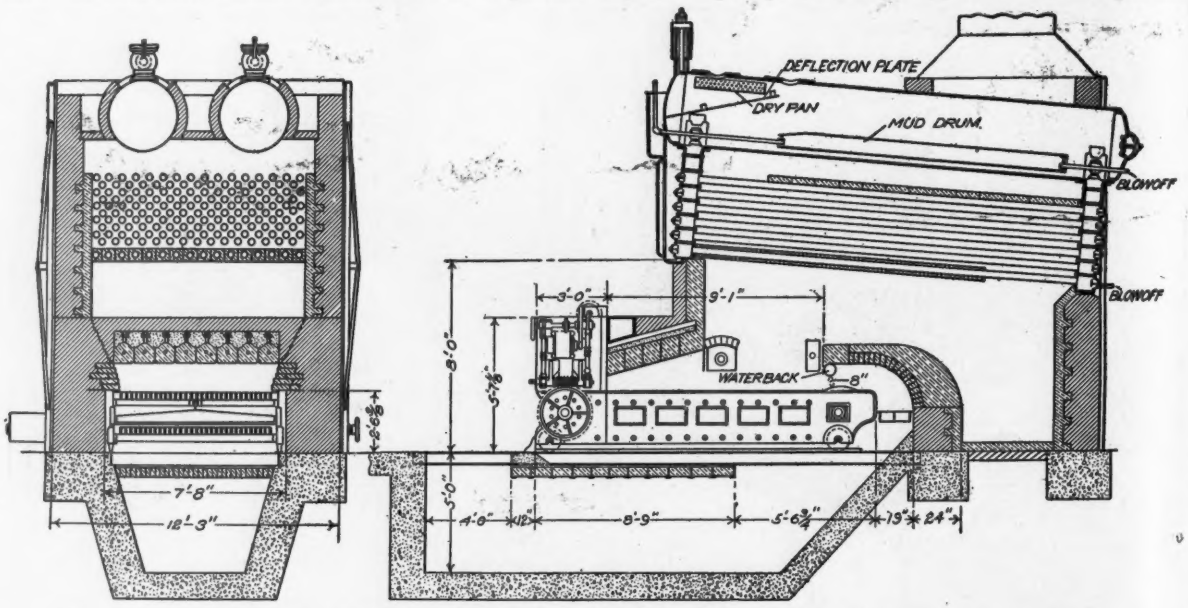


FIG. 3. CROSS-SECTIONS OF HEINE WATER-TUBE BOILER EQUIPPED WITH M'KENZIE CHAIN GRATE

Cadman angle blowoff valves, thus securing a perfectly tight blowoff pipe. The sludge is discharged into a blowoff basin which is vented to the stack shaft.

Near the front of the boiler shell, over the throat and slanting to the rear is a deflection plate which keeps the spray of water which forms over the front throat from going directly to the steam pipe, and an additional provision to secure dry steam is a dry pan placed below the steam opening and over the deflection plate. This is made of sheet iron in the shape of a box, with a large number of holes in its sides.

The 2 waterlegs consist of a tube sheet and a handhole sheet, which are machine flanged and joined together all around except at the top by a butt strap and held from bulging by hollow stay bolts screwed in, and upset on the outside. These stay bolts are placed in such a position that the soot can be blown off the water tubes by a jet of steam through them. For this purpose a Bayer soot blower is provided which has steam nozzles fitted into the hollow stay bolts, all connected to one steam pipe by means of which the soot can be blown off the tubes by merely opening the steam valve, thus preventing air from entering the combustion chamber, as the nozzles fit the stay bolts perfectly.

The waterlegs are set at right angles to the boiler shell, and the entire boiler is inclined downward from the front at a pitch of 1 in 12. The course of the gases is from the furnace underneath the front of the boiler, through the combustion chamber to the rear of the water tubes, being deflected by a tile baffle on the lower row of tubes. From the rear of the water tubes the gases pass parallel to the tubes and in the direction of the flow of the water to the front waterleg, this course being directed by a tile baffle placed on the upper row of water tubes, thence, beneath the boiler shell to the breeching which is placed above the rear of the shell.

As will be noted from the plan view, all boilers are connected to one breeching which is 62 by 78 in., and

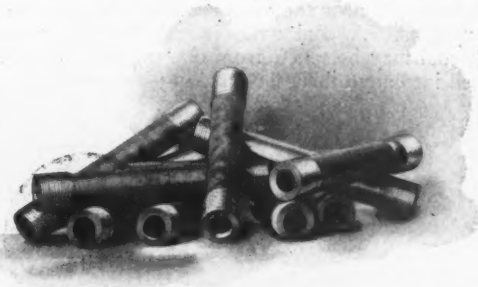


FIG. 6. HOLLOW STAY BOLTS FOR BRACING WATERLEGS

conducts the flue gases to the chimney. The stack is 314 ft. high and 6 ft. in diameter, made of metal, enclosed by a brick shaft, 7 ft. square. Inside this shaft are also placed the exhaust pipe and vent from the feedwater heater. Another function of the shaft is to act as an air duct to ventilate the engine room.

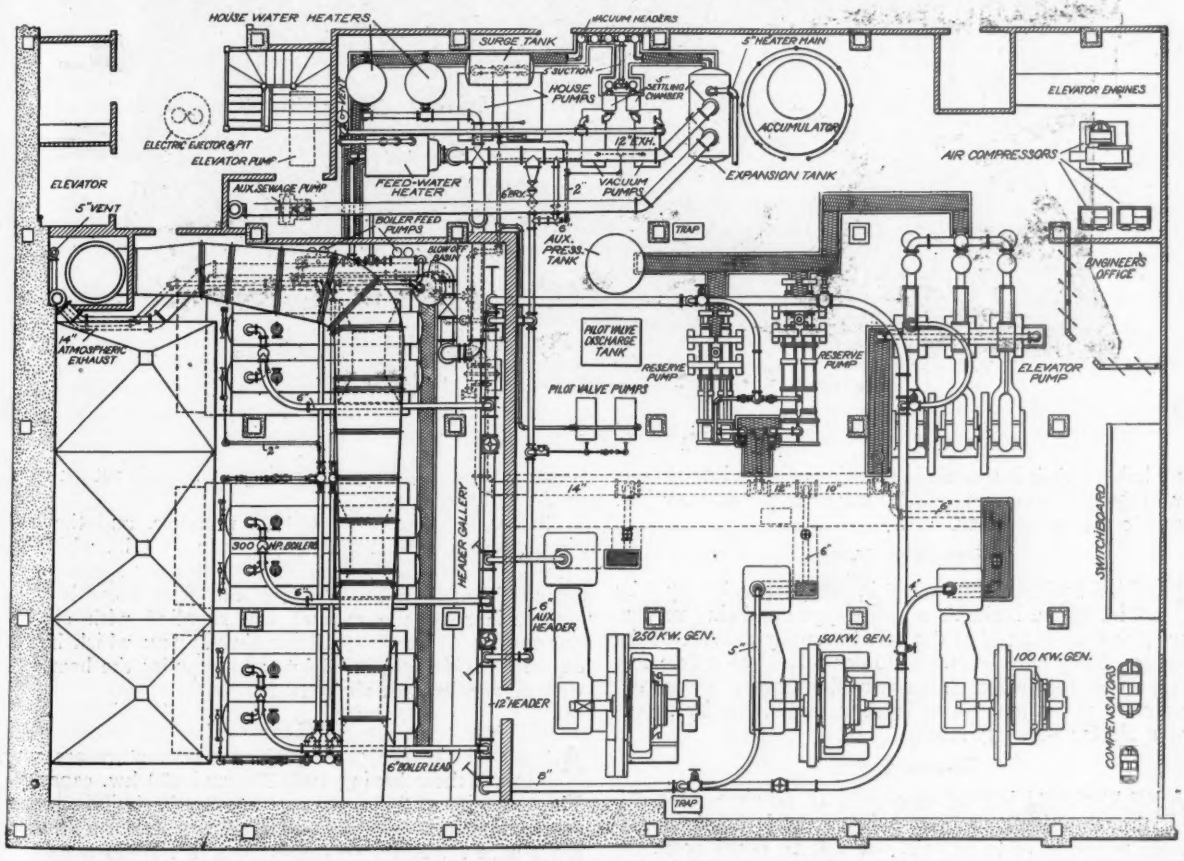


FIG. 4. GENERAL PLAN OF THE POWER PLANT AND PIPING

Each boiler is equipped with a McKenzie Chain Grate Furnace with an active surface 7 ft. by 9 ft. 1 in. The furnace is operated by a direct connected Crocker-Wheeler motor, and is provided with a water back and 4-ft. ignition arch, both of which are of the standard McKenzie construction.

Other fixtures of the boilers are Gould water columns, Foster feed-water regulators which control the pump governors, Ashton steam gages, and pop safety valves.

Three coal hoppers with a total capacity of 310 tons are placed in front of the boilers from which chutes run to the stokers. These hoppers being located beneath the street level and near the alley are filled directly from the coal wagons. A coal scale is provided by means of which coal may be taken from one hopper, weighed and dumped into any other, thus making it convenient to test any boiler. Ash is shoveled from the ash pits into barrels and taken to the street level by means of an elevator just outside the boiler room.

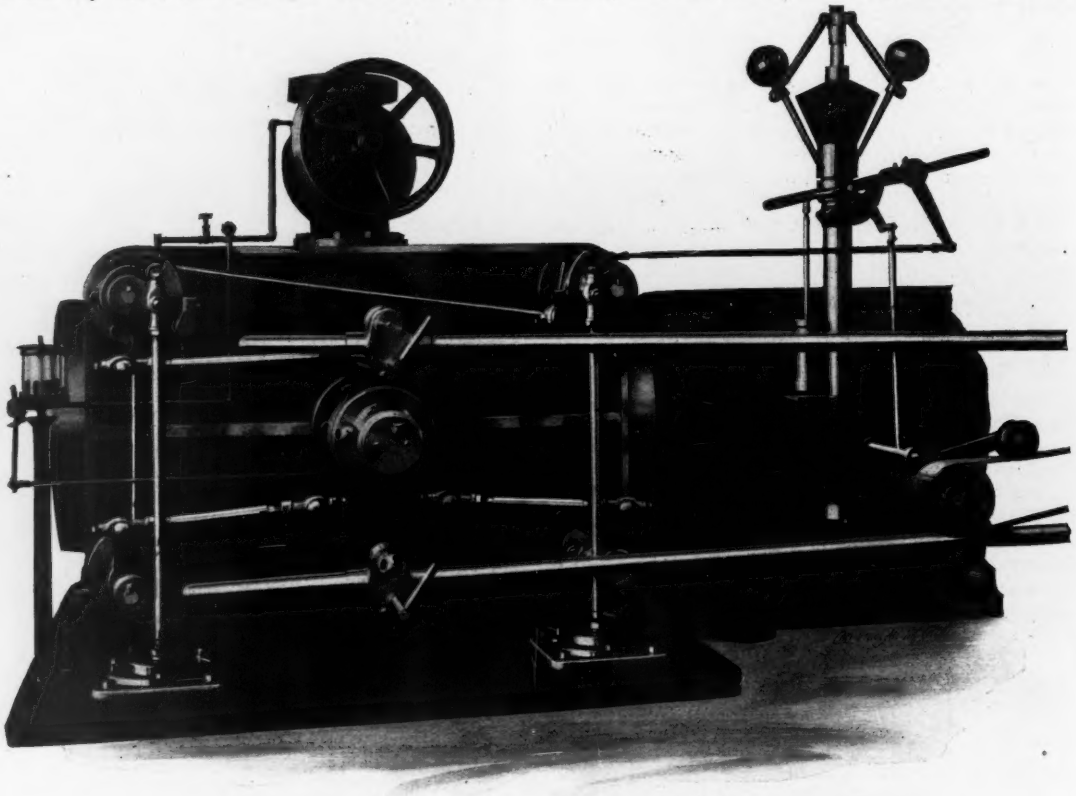


FIG. 7. VALVE GEAR AND GOVERNOR OF FILER & STOWELL ENGINES

Boiler-Feed Pumps

THE boiler-feed pumps are 2 in number, each 8 by 6 by 12 in. of the Blake Admirality type and being vertical are placed at one end of the boiler room by the side of the boiler. They take hot water under a head of a few feet from the feed-water heater in the engine room and maintain a constant water level in the boilers by means of a Foster pump governor.

Engine Room

ARRANGEMENT of apparatus in the engine room is the most simple and convenient possible for the conditions which have to be met. It will be noted from the illustration that the generating units are placed in one row, the elevator pumps in the second, and the house and vacuum pumps, feed-water and house-water heaters in the third row, giving 2 main aisles from which the engineers have access to the machinery.

Three Filer & Stowell Corliss engines are used, direct connected to Crocker-Wheeler generators and supplying all electrical power for the building. The engines are all simple and noncondensing. Engine No. 1 is 14 by 30 in., connected to a 100-kw. generator and is equipped with a single eccentric. Engine No. 2 is 16 by 30 in., connected to a 150-kw. generator and equipped with a double eccentric. Engine No. 3 is 18 by 32 in., connected to a 250 kw. generator, and also equipped with a double eccentric. All the engines run at 110 r.p.m. and have flyball governors with safety stops; the cylinders are provided with indicator piping for testing purposes. To insure the engines against wet steam, each is supplied with a Cochrane steam separator, drained to a single Cranetilt return trap in the exhaust tunnel.

Steam is supplied at 150 lb. pressure, and the engines operate against a back pressure of 1 lb. which is carried on the Van Auken vacuum heating system employed throughout the building and feed-water heater.

Bearings of the engines are supplied with oil by means of a White Star oil filtering system which has a capacity of 200 gal. in 24 hr., and supplies the bearings with oil at a head of about 10 ft.

Generators

AS stated above, Crocker-Wheeler generators are employed, these having 100, 150, and 250 kw. capacity. They operate at 250 volts and supply the building with current on the 3-wire direct-current system. To balance the 3-wire system, 2 sets of balancing transformers are employed, made by the Crocker-Wheeler Co., one operating at 1300 r.p.m., 125 volts and 100 amperes, the other at 1500 r.p.m., 125 volts, and 50 amperes.

Switchboard

THIS is a model for isolated plants in office buildings, being simple in construction without the unnecessary features which are so frequently placed upon switch-

boards for this class of service. It consists of 3 generator panels upon each of which are mounted 2 circuit breakers, 1 ammeter, 1 rheostat, voltmeter plug receptacles and light, 3 single-pole single-throw switches and 1 recording wattmeter. The fourth panel contains 3 graphic recording wattmeters, while the fifth and sixth panels are for controlling the balancing transformers. Each of these has 1 2-way ammeter, 1 rheostat, 2 2-pole single-throw switches, and voltmeter plug receptacles. Upon these panels also are located the 2 main voltmeters of the station, one giving the voltage of the generators, the other that of the balancers.

In addition to these panels are 3 which contain the distributing switches for controlling the light and power of the building, while above the board is an attractive, as well as useful, ornament, the clock. All the indicating instruments were made by the Weston Electrical Instrument Co. and have illuminated dials; Thompson recording wattmeters, Cutler-Hammer rheostats equipped with endless chain and hand wheel, Westinghouse graphic recording wattmeters and Crouse-Hinds switches are used.

Elevators

ELEVATORS in the building consist of 9 passenger and 2 freight; 1 freight starts at the third basement, 1 passenger at the second basement, 1 passenger and 1 freight at the first basement, the rest all start at the main floor, and all run to the top of the building.

Elevator Pumps

ALL elevators are operated by hydraulic pressure which is furnished by Laidlaw-Dunn-Gordon Co.'s elevator pumps, the main pump having 3 cylinders with Corliss valve gear, plungers outside packed, and controlled automatically by the accumulator. The steam pipe leading to this pump is provided with a Cochrane steam separator, and in order to check up water used a revolution counter is placed upon the pump.

Aside from the main elevator pump there are a compound duplex pump 14 and 20 by 5½ by 18 in., and a simple duplex 16 by 5½ by 18 in., both having outside packed plungers and being automatically controlled. The hydraulic pressure supplied by these pumps is 800 lb. per square inch, the steam pressure being 150 lb., and the exhaust 1 lb. back pressure.

For controlling the elevators, 2 pilot valve pumps are employed. These were made by the Laidlaw-Dunn-Gordon Co., each simple duplex, with the dimensions 7½ by 4½ by 10 in.

Compressed Air System

LOCATED in the engine room are also 3 motor-driven air compressors. One of these was made by the Chicago Pneumatic Tool Co., and has an air cylinder 8 by 8 in., and supplies air for cleaning the generators. The other 2 compressors were made by the National Electric Co., are 2½ hp., running at 1350 r.p.m., requiring 10.5 amperes at 220 volts. These are automatically operated and used for supplying compressed air to the heat regulating system, which is that devised by the Johnson Service Co.

The elevator accumulator and exhaust steam expansion tank are located near the north side of the engine room. Compressed air used in the elevator system is supplied by a Westinghouse air compressor, 8 by 6 by 10 in., also located in this part of the engine room. Two vacuum pumps for the heating system are employed which were made by the Knowles Steam Pump Works, and are of the simplex type with dimensions 8 by 12 by 12 in., each being supplied with a pump governor which maintains a constant water level in the expansion tank.

Pumps for supplying hot and cold water to the building were made by the Geo. F. Blake Mfg. Co., and consist of 2 duplex, each 12 by 7 by 10 in., supplied with Fisher Governor Co.'s pump governors. All steam cylinders on pumps and engines are lubricated by means of Hills-McCanna oil pumps.

Two house-water heaters of the closed type made by Wm. Baragwanath & Son, are employed, each having a capacity of 800 gal. per hour. They are supplied with

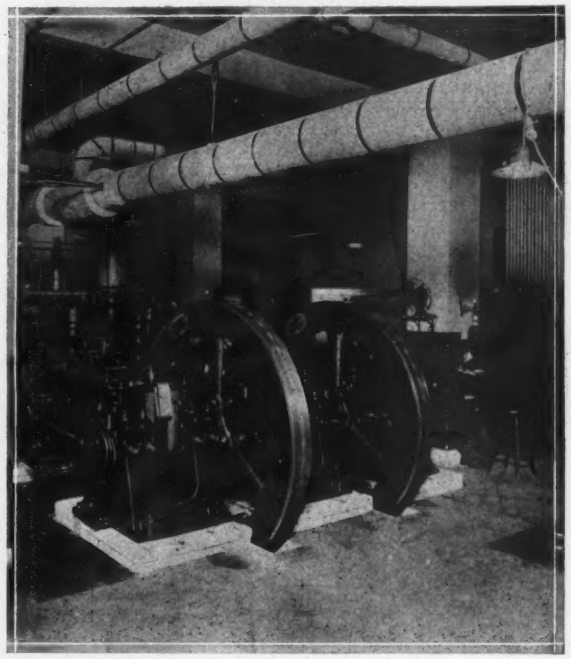


FIG. 8. MAIN ELEVATOR PUMP IN M'CORMICK BUILDING

steam through a bypass pipe from the exhaust steam main, and each is equipped with a Powers temperature regulator.

A Cochrane feed-water heater of 3000 hp. capacity heats all water before it enters the boilers by means of a bypass from the exhaust steam pipe. This is of the latest model made by the Harrison Safety Boiler Works, of the open type and equipped with an oil separator.

Located at the north end of the main aisle is the gage board equipped as follows: The house tank service gage, registering on the average 140 lb., elevator pressure gage reading 800 lb., steam gage on main header 140 to 150 lb., heating system 1 lb., all of these gages being made by the Ashton Valve Co. There is also located on this board an Ellison differential draft gage which registers 1.4 in. as average draft. Another of these draft gages is placed in the boiler room to guide the fireman.

As a check on the combustion secured in the boiler furnaces a Hamler-Eddy smoke recorder is employed, the gases being taken directly from the main breeching leading from the boilers and piped to the instrument which is placed in the engine room.

To secure the best regulation of the boilers a damper regulator is employed which was made by the Spencer Regulator Co.; this is also placed in the engine room.

Piping System

THE intricate problem of the steam piping system, which is required in an office building power plant, is here solved admirably. The 2 drums of each boiler are connected together by 6-in. pipes and a 6-in. tee connects

these to the boiler lead through an angle valve, thence to the main header of the plant which is a 12-in. pipe extending the entire length of the boiler room at the rear of the boilers, and made accessible by a header platform which is reached from either the engine room or the boiler room. This header is supplied with 2 bypass gate valves to enable the operation of one boiler without interfering in any way with the others.

run. The exhausts from the house and vacuum pumps are piped to the exhaust main in the boiler room before it enters the oil separator and the steam passes to the feed-water heater, house-water heater, and vacuum heating system.

A Foster back-pressure valve is placed in the exhaust pipe just before it passes to the atmospheric exhaust and a Swartwout exhaust head is placed at the end of the pipe

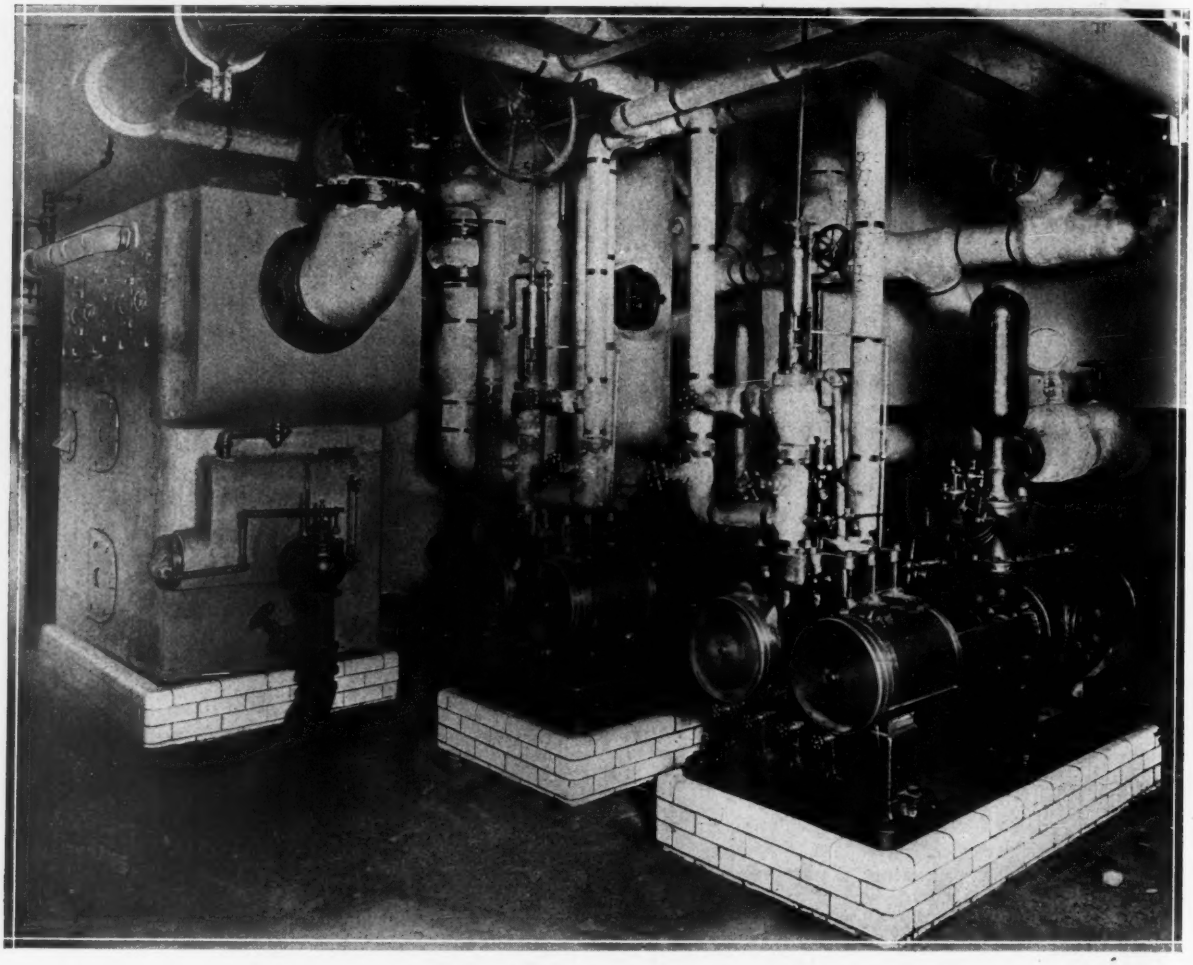


FIG. 9. HEATERS AND HOUSE PUMPS

The main steam line is a loop of 8-in. pipe connected near each end of the header. This is divided into 3 sections each of which is supplied with a Cochrane steam separator and Cranetilt return trap. Engine No. 3 is piped directly to the main header in the boiler room by a 6-in. pipe. Each of the other 2 engines and the main elevator pump are connected to the separate sections of the loop. All pumps are connected to an auxiliary 6-in. header hung in the engine room and carry a pressure of 150 lb. Long sweeping bends in the steam pipes are used where needed and not the slightest vibration is noticeable.

This arrangement of piping will enable the test of any boiler or main unit without interfering with the operation of the other units of the plant.

The main exhaust pipe is located in the tunnel beneath the main aisle of the engine room from which it runs to the boiler room, through an oil separator and to exhaust or the heating system. To this pipe the exhausts from all generating units and elevator pumps are

which extends to the top of the building. In order to supply live steam to the heating system at any time it is found necessary, a Foster pressure-reducing valve is con-

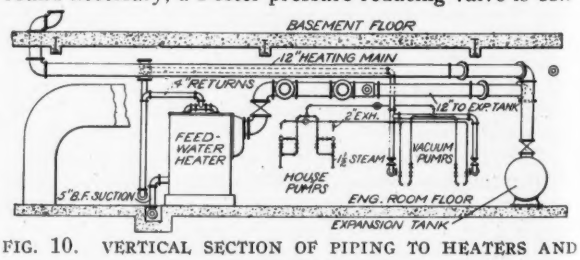


FIG. 10. VERTICAL SECTION OF PIPING TO HEATERS AND PUMPS

nected between the auxiliary header and expansion tank.

All steam lines are insulated with 85 per cent magnesia covering and the hot-water lines with felt covering. Lunkenheimer steam valves are employed throughout the

plant, while the water valves were made by the Nelson Valve Co. On the high-pressure hydraulic piping for the elevators, Crane valves and fittings are used.

All sewage below the street level drains to a sump in the third basement from which it is pumped to the city sewer system by means of a Yeoman's Electric Ejector. An auxiliary sewage pump also is provided, this being a Worthington 6-in. volute centrifugal pump, driven by a vertical engine made by the Marine Engine Works, and is located just outside the boiler room on the same floor, as shown in the plan view.

Accommodations for the engineer and his force of operators have not been overlooked in the design of this plant and his office is located at one end of the engine room enclosed by windows from which he can see almost the entire engine room. There are located in this room 2 Ashton recording gages, one being for steam and the other for the vacuum carried on the heating system. Architectural work of this building was done by Holabird & Roche, while M. T. Kimman, chief engineer of the McCormick estate had charge of the power-plant design and equipment and J. J. Kimman is the chief engineer for the building.

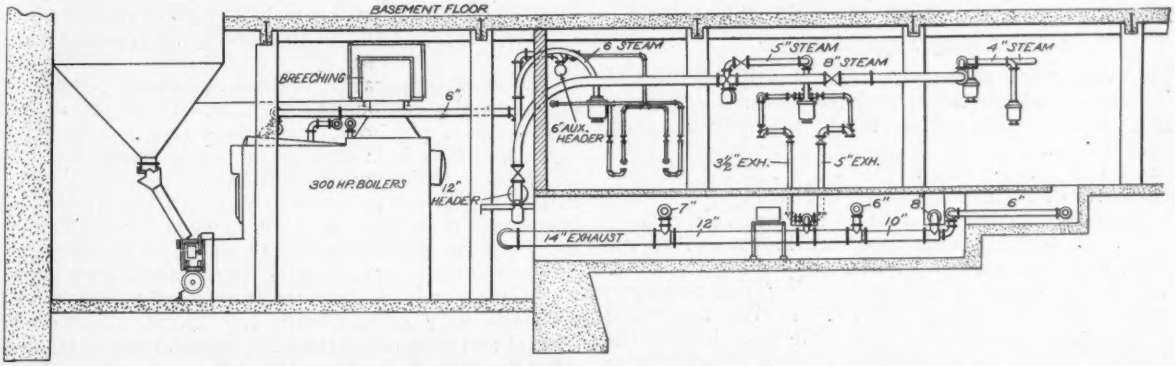


FIG. 11. VERTICAL SECTION OF STEAM AND EXHAUST PIPING TO MAIN UNITS

SETTING STEAM PUMP VALVES

ONE of the many arts which must be mastered by the power plant operator is that of setting the steam valves of boiler-feed pumps. There is little that can be said in a general way regarding the setting of the valves of a simplex pump as the principles of each make are entirely different. It may be said, however, in a general way that all simplex pumps operate their valves by a lost motion device acting at the end of each stroke and in order to keep the efficiency of the pump as high as possible the valves should be set to give the longest stroke obtainable.

Duplex pumps differ but little in their valve motion and the following method with a few modifications will apply in a general way to all duplex pumps, having the lost motion at the valve.

After placing the rocker arms plumb, measure the width of the steam port and then set the valves squarely over the ports so that both steam ports on both sides of the pump will be closed. The space between the nuts and the lugs on the backs of the valves should be equal to one-half the width of the steam port, that is, if the valves were now to be moved in either direction, the steam ports would be one-half open. Two wrenches should be provided, one to hold the nut nearest the valve while the other is being tightened. If only 1 wrench is used the inside nut is liable to be moved while tightening the outer one, which will necessitate going over the work again.

As the valves will now be in a position to prevent entirely the admission of steam into the cylinders it will be necessary to move at least one of them so as to open one of the ports. The chest cover may then be put on and the stuffingbox glands tightened sufficiently to prevent leakage. If, upon starting the pump, 1 piston should move slowly when approaching the end of the stroke, or perhaps fail to complete the stroke, the pump should be stopped after the piston has moved as far as it will go and the chest cover removed.

It will generally be found that the port admitting steam is not wide open, which may be due to one of the nuts having been moved too far. Increasing the lost motion lengthens the stroke and decreasing it shortens the stroke. If the port is found to be wide open the difficulty will be found in the cylinders or in the stuffingboxes on the piston rods. An overtight stuffingbox will sometimes stop a pump dead.

HIGH EFFICIENCY WITH LOW-GRADE FUEL

BURNING low grade bituminous coal under steam boilers with good economy is a question of great interest to all power producers. If an engineer could be sure of economy with low priced coal he would usually use it. Results obtained in a recent test at the Viaduct Power Station of the Cleveland Railway Co. are, therefore, significant. This boiler is a 512-hp. Babcock & Wilcox unit with Taylor underfeed gravity stoker. Coal used was a low grade bituminous slack with heating value of 12,350 B.t.u. per pound of dry coal, and the proximate analysis as follows: Moisture, 4.5 per cent; volatile 34.4, fixed carbon 49.8, ash 15.8. The ash percentage, as noted, is high, but notwithstanding this, an overall efficiency of nearly 80 per cent was obtained and the coal was burned almost without smoke. Some of the results are as follows:

Total coal fired, 20,200 lb.; dry coal, 19,291 lb.; total water evaporated 196,669 lb.; dry coal per sq. ft. of grate, 31.02 lb.; horsepower developed, 712.57; builders' rating, 512 hp.; so that the actual performance was 139.16 per cent of the builders' rating. Water evaporated from and at 212 deg. F. per pound of dry coal, 10.2 lb. This gives boiler efficiency 82.37 per cent, stoker efficiency 96.79 per cent, and overall efficiency 79.72 per cent. The analysis of the flue gases showed in the last pass 13.33 per cent carbon dioxide, 6.37 per cent oxygen, 0.22 per cent monoxide and the average smoke reading, based on the Ringelmann chart, was 6.1 per cent.

DETAILS OF POWER PLANT DESIGN

CAPACITY, CONSTRUCTION AND SETTING OF BOILERS

By Chas. L. Hubbard

HAVING determined the necessary boiler horsepower for a given plant the next step is to decide upon the type and size of boilers and the number of units. In the selection of a boiler, no hard and fast rule can be followed, as much depends upon the price to be paid, available space, quality of feed water, pressure to be carried, etc. Under the same general conditions there is probably very little difference in the operating economy of different types of first class boilers.

Choosing Type of Boiler

AN examination of the plants in recently constructed office buildings would probably show the employment of water-tube boilers in the majority of cases. Besides the advantage of greater safety, may be mentioned the greater efficiency of the heating surface, due to its direct exposure to the burning gases, and to the more rapid circulation of the water; the large draft area, which causes a slower movement of the gases, and thus gives a greater opportunity for their heat to be absorbed before entering the chimney; riveted joints are removed from the fire; and there is less chance for sediment and scale to collect on the heating surfaces on account of a rapid circulation in one direction. As the fire is in contact with the outside of the tubes, there is less opportunity for the accumulation of soot and ash.

In general, boilers of this type are more compact for a given capacity, which is an important point in buildings of this kind. On the other hand, there are many engineers who still prefer the older form of horizontal boiler with fire tubes. This has a greater water capacity, which results in a less rapid fluctuation of the water line, and thus requires less careful attention; the first cost is less; and it is better adapted to low basements than some of the forms of water-tube boilers.

The number of units will depend upon the size of the plant and the general form of the boiler room. There should always be at least one spare boiler for use in case of a breakdown or when cleaning; and in plants of large size, the number of reserve boilers should be increased, not only as a matter of precaution against emergencies, but it allows a better opportunity for cleaning and repairs without forcing those which are in commission.

Boiler Rating

BOTH water-tube and fire-tube boilers are rated according to their heating surface; the former being rated at 10 sq. ft. of heating surface per horsepower, and the latter at 12 for power boilers, and 15 for the medium and smaller sizes of heating boilers. The smaller amount of heating surface in the water-tube boiler is due to the greater proportion which is directly exposed to the fire, and to the more rapid circulation of the water, as already stated. The larger amount of heating surface required in heating boilers is due principally to less care and skill in operating them. The required grate area depends upon the rates of combustion per square foot of grate surface and the evaporation per pound of coal.

The coal burned per square foot of grate per hour in power plants with natural draft will average from 12 to 15 lb. for anthracite, and 15 to 18 lb. for bituminous. When forced draft is employed, a combustion of 20 to 30 lb. is commonly obtained. The rate of evaporation in power boilers, with clean tubes, usually runs from 8 to 10 lb. of steam per pound of coal.

The grate area in any particular case may be found by multiplying the rated horsepower of the boiler by 34.5 and dividing this product by the pounds of water evaporated per pound of coal, and divide again by the pounds of coal burned per square foot of grate surface, the result will be the total grate area in square feet.*

With an evaporation of 10 lb. of steam per pound of coal, and a combustion of 15 lb. of coal per square foot of grate per hour, which may be taken as average conditions in a first class power plant, 0.23 sq. ft. of grate surface are required per horsepower. The ratio of heating to grate surface in power boilers commonly runs from 40 to 50, or even more. Taking these figures and assuming 10 sq. ft. of heating surface per horsepower, we find the required grate areas to be 0.25 and 0.20 sq. ft., respectively, which corresponds very closely with the above. The grade of fuel and rate of combustion, general character and arrangement of the heating surfaces, however, have an important bearing upon the most efficient ratio between heating and grate surface.

In any given boiler, there is a limit to the quantity of heat which it can absorb economically, so that, if the rate of combustion is increased, the grate area must be correspondingly diminished. For the best economy, a power boiler should be so proportioned as to have at least 1 sq. ft. of heating surface for each 3 lb. of water evaporated from and at 212 deg. per hour. This gives an average coal consumption of $10 \times 0.3 = 3.3$ lb. per horsepower per hour. These figures will vary somewhat with the quality of the coal, but will be found useful in making approximations for average boiler practice.

Tubes and Braces

WHEN tubular boilers are used, care should be taken not to crowd the shell too full of tubes as is sometimes done to secure a maximum amount of heating surface in the smallest possible space. Overcrowding in this way interferes with the free circulation of water within the boiler, and thus lowers the efficiency; again, if the tubes are carried too near the shell, the construction becomes too rigid, and leaks are likely to develop, due to the continual expansion and contraction of the boiler while in use.

The accompanying table, given by the writer in The Iron Age, July 15, 1909, gives the number and size of tubes recommended by the Hartford Steam Boiler Inspection and Insurance Co. for boilers of different diameters, and may be repeated to advantage in the present article.

In bracing the heads of a boiler the matter of accessibility to the interior for purposes of inspection, should be considered as well as the matter of strength. This precludes the use of complete "through" bracing

*In short form this becomes:

$$S = \frac{bp \times 34.5}{E \times C}, \text{ in which}$$

S = total area, in square feet.
E = pounds of water evaporated per pound of coal.
C = pounds of coal burned per square foot of grate per hour.

in boilers of small and medium size. In instances of this kind, diagonal staying by means of solid steel braces is preferable, as this leaves the central portion of the shell beneath the manhole free for entering the boiler. In larger sizes, a combination of through and diagonal bracing may be used to advantage. In cases of this kind, 3 through braces are generally used in a horizontal row for supporting that portion of the head directly above the tubes, and diagonal stays for the remainder. This method is commonly employed in boilers 54 and 60 in. in diameter. For 66 and 72-in. boilers it is more usual to employ through braces entirely, as in shells of this size there is room to spread the 2 upper braces sufficiently to allow a man to pass between them.

For all power work it is best to use the triple riveted butt-joint for the longitudinal seams. Lap joints

TABLE SHOWING THE NUMBER AND SIZE OF TUBES FOR TUBULAR BOILERS

DIAM. OF SHELL IN INCHES	DIAM. OF TUBES IN INCHES	NUMBER OF TUBES
36	2¾	34
42	3	34
48	3	44
54	3	54
60	3	72
60	3½	46
66	3	90
66	3½	64
72	3	114
72	3½	98

are no longer used in the best class of work, even for low pressures, although giving sufficient strength when new, they are apt to become weakened by constant expansion and contraction.

Boiler Foundation

PLANS for setting water-tube boilers are usually furnished by the makers or else the boilers are erected by them ready for the steam and water connections. In the case of horizontal tubular boilers the settings are commonly designed and constructed under the direction of the engineer.

The first requirement of a good setting is a substantial foundation. This at the present time is usually constructed of cement. Where the soil is firm the width of the foundation walls may be made 16 to 18 in. wider than the walls of the setting which they are to support, thus allowing a projection of at least 8 in. on each side. In the case of heavy settings for power work, the foundation should be made 20 to 24 in. wider than the brick work, and if the soil is at all yielding, it is better to provide a solid bed of concrete of sufficient size to take the entire setting. The depth of the foundation should be made from 24 to 30 in., depending upon the size of setting and nature of the earth footing.

These dimensions apply to average requirements. If there are special conditions to be met the foundations must be designed accordingly. A good concrete is obtained by using 1 part Portland cement, 2 parts sharp sand, and 4 parts of broken stone, the pieces of which should not be over 2 in. through. Concrete should be put down in layers not over 6 in. in thickness, each layer being thoroughly rammed before the next one is laid.

Walls and Supports

WALLS of the setting should be of best quality hard-burned brick laid in freshly made cement mortar, which may consist of 1 part Portland cement to 2 parts of sharp sand. The furnace, and such other parts as are exposed directly to the flame and hot gases should be lined with firebrick laid in pure cement or a mixture of fire clay and ground fire brick, with very close joints. In the best class of office buildings the outside of the setting is usually finished with white enameled brick.

If the usual form of setting for horizontal tubular boilers is employed, where the entire weight is carried by the side walls, great care should be taken to allow spaces at the rear of the boiler and back of the rear lugs so that the brickwork will not be cracked by the expansion of the shell. The best form of setting for power boilers of this type is where they are hung from overhead girders resting on independent columns. In this way all load is removed from the setting, which, on this account, may be made considerably lighter, and if properly constructed, the boilers will swing clear of the brickwork in such a manner that cracks will not be formed by the expansion of the shell.

Furnace Equipment

THERE are so many different forms of grates, stokers, and smoke consuming devices upon the market that only a few general directions regarding the equipment of the furnace can be given in the space available in the present article. In general, grates should not be larger than can be easily fired and cleaned. For this reason furnaces which are to be fired by hand should not be over 6 ft. in length, and if over 4 ft. wide should have 2 fire doors.

Under average conditions, the free area for the passage of air varies from 30 to 50 per cent of the total area, depending upon the kind of fuel. With small sizes of anthracite the air spaces are often made ¼ in. or less in width, while with bituminous or coking coal, 1-in. spaces are often necessary. The plain hand-fired grate has been quite generally replaced by some form of shaking or roller grate in the modern power plant of small and medium size, and by the mechanical stoker in those of larger size. An objection sometimes raised against shaking grates is the loss from unburned coal which falls into the ash pit. This ordinarily amounts to from 1 to 3 per cent of the total coal consumed, even with the most careful handling, but this is, in general, more than offset by the improved combustion due to the greater freedom from refuse.

Mechanical stokers are employed both as labor saving devices, and for more uniform and efficient firing. With a good form of stoker 1 man can care for several furnaces. As most stokers operate with closed furnace doors, and feed the coal at a uniform rate as required, they are more economical in the use of fuel than hand firing.

Smoke Prevention

ANOTHER important item in equipping a boiler plant in a city is the matter of minimizing the production of smoke. There are various devices on the market for this purpose, but probably the most efficient "smoke preventer" is a skillful fireman.

Some of the best forms of mechanical stokers are also effective as smoke preventers, being so arranged that the fuel is first subjected to a coking process, and the volatile products burned off over the incandescent coal occupying the main portion of the grate. The coke is then pushed further into the furnace where it burns without smoke and fresh fuel is added to the coking section of the grate near the feed door.

In other smoke preventing devices, heated air, or a mixture of air and steam is introduced into the furnace over the feed doors or along the bridge wall to produce of more complete combustion.

SETTING SLATER ENGINE VALVES

WITH DESCRIPTION OF THE GEAR AND GRID-IRON, DROP CUTOFF VALVES

By Frank W. Carey

THESE engines are now built and repaired by the Warren Steam Pump Co., Warren, Mass., which has purchased the machinery, patterns, etc., of the Slater Co. Figure 1 shows a view of the valve-gear side of one of the engines and Fig. 2 valve motion and cross-sectional drawing.

The Valves and Gear

THESE engines are of the drop cutoff type, cutoff being accomplished by the drop of multiported or gridiron valves, which are shown in Figs. 2 and 3. The ports of admission valves have ample area, so

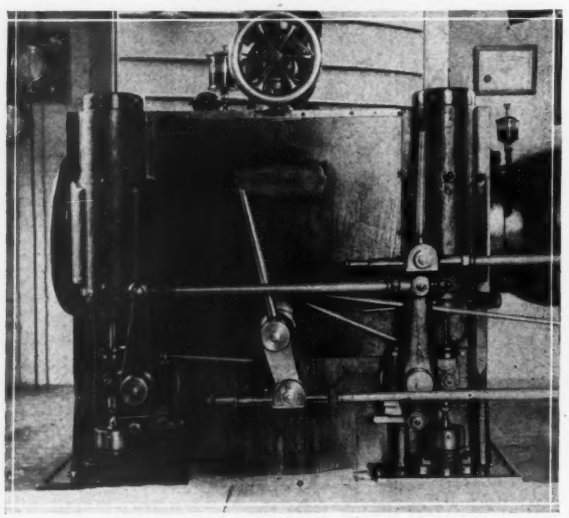


FIG. 1. VALVE-GEAR SIDE OF SLATER ENGINE CYLINDER

there is very little drop in the steam line as shown in Fig. 4. With the steam pipe of reasonable size and not too long any of these engines will take as good a card as the one shown provided that the valve setting has been properly done.

The exhaust valves, Figs. 2 and 3, are of the multiported rotary type and, owing to their location at bottom of cylinder, provide ample drain for a reasonable amount of water. Both admission and exhaust valves have removable seats, ground into cylindrical chambers, this being a valuable feature in case of repairs.

All engines of this type have separate steam and exhaust eccentrics, therefore have the longest possible range of adjustment obtainable. They are built to run up to 150 r.p.m., although the majority are running at 90 to 100 r.p.m.

Figure 5 shows the governor used on these engines, a type familiar to all, the only special features being the safety stop and the governor cam. There is a sleeve or loose bushing on the governor at C, with slots, through which pass arms for the governor drop rod and governor dash pot rod.

When the engine is to be shut down or when about to set valves, the sleeve is rotated slightly by means of the lever shown, so that notches in the slots support the governor by means of the arms mentioned. The governor is now in its position for longest cutoff which is 5/8 stroke.

Should the governor belt break, when running, the governor would immediately drop, not on the sleeve, but, owing to the sleeve being turned so that the notches are clear, to its lowest position and the latch would not engage the latch block so that the engine would stop.

Setting the Valves

THE first thing to do is to adjust guide L and dash pot O, Fig. 2, in their proper positions; in order to do this, it is necessary to know the valve travel and lap.

If the lap and travel are not known, remove one of the valves and measure the bars on the valve to get

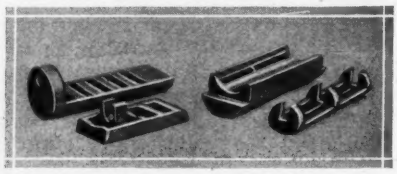


FIG. 3. PERSPECTIVE VIEW OF VALVES

the width. Then measure the ports in the seat, which should be the same width as the ports in the valve. For example take the valve and seat from a 24 in. cylinder; valve and seat have bars 1.25 in. wide, ports 0.75 in. wide, so lap is 1.25—0.75÷2=0.25 in.

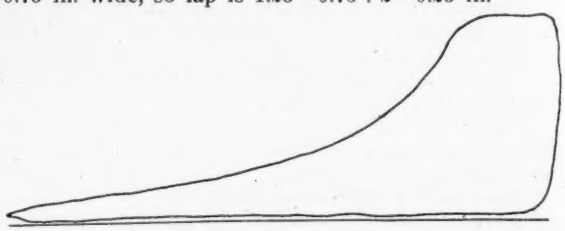


FIG. 4. INDICATOR DIAGRAM FROM SLATER ENGINE

Now the valve travel will be 0.75 in., the width of port, + 0.25 in. lap. = 1 in.

With bell crank G in a vertical position with latch C hooked on, the dash pot should have raised 0.5 the valve travel, which in this case is 0.5 in. If it is not, screw dash pot N in or out of valve stem guide K as required. With this done the next thing is to set the valves so that they have the required amount of lap, which varies on different sizes of cylinders but in the case under consideration it is 0.25 in.

The surest and best way to set the valve in reference to lap is to do it before the steam valve chest cover or bonnet is put on. Proceed as follows: With the dashpot down, lower carefully the steam valve, with stem M attached, into the chest; note when the valve is in position for full port.

Next lower valve stem into guide, and adjust so that you have moved the valve exactly 1 in. from the full port position, because port+lap=travel=1 in. This, it must be remembered, varies on different engines. The valve is now in its correct position in relation to lap.

After you have done this and are sure that it is correct, don't change this adjustment for any reason,

for by so doing the valve will have more lap on one side than on the other, consequently will wear unevenly.

The next step is to get the eccentric rod the right length; by rotating the eccentric on the shaft, set the rod so that the rocker and bell-crank travel an equal distance each side of a vertical central line. Now with hook rod A on, place the steam eccentric on its dead center at the crank end; the latch steel D should now have hooked onto or engaged the latch block steel F, and have a clearance of about 1-32 in. between them. Next place the engine on its crank end dead center, and now turn the eccentric in the direction that the engine is to run until the valve opens 1-64 in.; this opening can be measured best by a thin piece of steel or brass 1-64 in. thick, which will enter when the valve has opened just enough.

Follow these directions for the head end and with the engine on head end center adjust for lead by right and left rod R connecting the bell crank levers G. If directions have been followed, the steam valve will now be properly set.

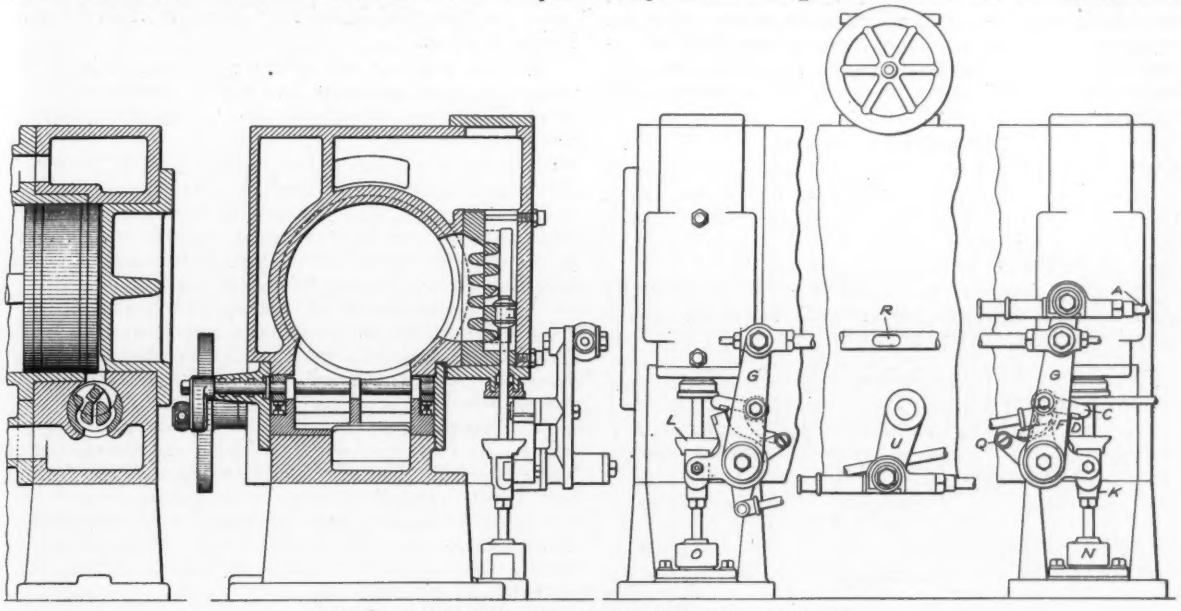


FIG. 2. VALVE MOTION AND SECTIONS OF CYLINDER

Exhaust Valves

SECURE the steam eccentric permanently in its place with the set screws. Next proceed with the exhaust valves. Adjust the eccentric rod so that the rocker travels an equal distance each side of a central line, also exhaust hook rod must be adjusted so that wrist plate lever U will travel equal distances each side of its central vertical line.

On the exhaust chamber head or bonnet will be found a scratch awl mark, Fig. 6, on the exhaust valve lever will be found 3 such marks. When the first mark on the lever is in line with mark on the bonnet, as in Fig. 6A, the valve is in its full port or wide open position. When the next mark on the valve lever is in line with the mark on the bonnet, as in Fig. 6B, the edge of the valve and edge of the seat are line and line, or just at the closing point. When the third mark on the lever is in line with mark on the bonnet, as in Fig. 6C, the valve is on full lap.

Now with wrist plate and lever in central position, adjust exhaust valve connecting rods A and B, Fig. 6D, so that the valves are line and line as in Fig. 6B. Then set the exhaust eccentric in its proper position on the shaft.

Turn the engine over until cross-head is within 2 or 3 in. of the end of the stroke, or wherever you desire compression to begin; 2 to 3 in. will be sufficient for a non-condensing engine; if engine is to run condensing, compression will have to begin earlier.

With crosshead in the position above mentioned, turn exhaust eccentric in the direction the engine is to run, until the exhaust valve is line and line with the seat as in Fig. 6B, and fasten the eccentric in this position; turn engine over to opposite position, and if the

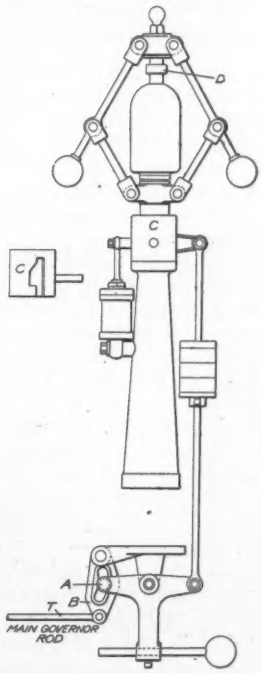


FIG. 5. SLATER GOVERNOR DETAILS AND ARRANGEMENT

valve on this end is found to be line and line with its seat, the valves are properly set.

After running and indicating the engine it may be found that it requires more or less compression. Then the eccentric must be moved ahead to get more and back to get less compression as the case requires. It should be remembered that when changing the point of compression we are also changing the point of release. The valve connecting rods A and B, Fig. 6D, should not be changed after being set correctly with reference to the wrist plate.

Setting the Governor

THE only thing left now is to adjust governor connections. With the governor in its longest cutoff position, which is when it is resting on the sleeve, adjust the governor drop rod so that cam roll A, Fig. 5, is in the center of the governor cam B.

Now by means of the hand lever move the valve gear by hand until one steam valve has raised its full travel which is, port plus lap, in this case 1 in.

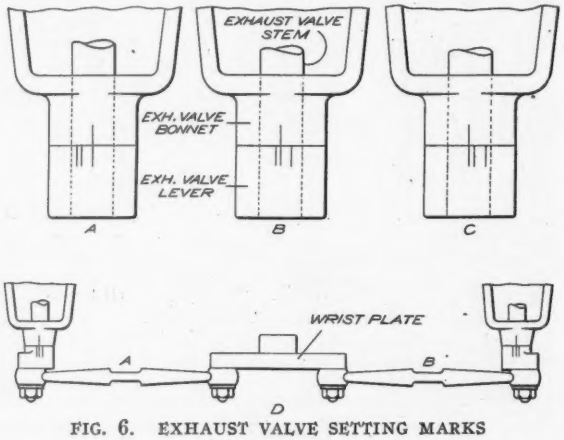


FIG. 6. EXHAUST VALVE SETTING MARKS

At this point, the valve must cutoff, so adjust the governor connecting rods so that the trip lever trips or knocks off the latch. Repeat this on opposite end.

Now raise the governor high enough so that latches do not hook on at all, and then adjust collar D on the governor spindle, so that governor cannot go higher. This is the position the governor would take in case of excessive speed.

If it was allowed to go higher, the tail of latch C, Fig. 2, would strike on the trip lever Q and it would be badly bent or more probably broken.

Let the governor drop to its lowest position, not resting on the sleeve but below the notches. In this position the trip levers will be in the same position as when the governor is in its highest position so that the valves will not open. This is what happens when the governor belt breaks, so it will be seen that with adjustments made as directed the engine will not take steam with the governor in either its highest or lowest position.

TO FIND THE CUBIC contents of a barrel, square the largest diameter and multiply by 2, to this add the square of the head diameter, multiply this sum by the length of the cask and by 0.2618, inside dimensions being used in all cases.

FOR TEMPERING SMALL drills, chisels, etc., for very light work, says W. F. Smith, of Baltimore, heat to a dull red and cool in a bar of common soap. The temper will be about right and no drawing will be required.

OPERATING RULES FOR BOILERS

TO persons having the care of boilers, the Fidelity and Casualty Co. of N. Y. gives the warning that "explosions or other accidents are often due to lack of care on the part of attendants" and lays down the following Rules for Operating High-Pressure Power Boilers:

1. On entering the boiler room, ascertain if the valves between the boiler and water column are open. Then blow down water column, noting the return of the water in the glass, and test the gage cocks, until absolutely sure of the water level. This should be done at the beginning and end of each watch.

2. Open each door to boiler at least once a day and look carefully for leaks at every possible point, noting tube ends, seams, and blowoff pipe in furnace. Examine carefully the fire sheets for bulges, bags, or blisters.

3. Have all defects and leaks repaired without delay.

4. Safety valves are liable to stick on their seats; they should therefore be raised carefully at frequent intervals. Attach a small wire cable to safety valve lever, pass it over a pulley, and bring the end down to a convenient place for ready service in lifting the valve. See that the outlet to each and every safety valve is full size of valve opening. When washing out boiler, oil safety valve with cylinder oil.

5. When steam gage indicates maximum load on safety valve approved in last report of inspector, the safety valve should be blowing off freely. If it does not, ascertain at once why not.

6. Keep gage cocks in good order and use them, as water glasses are very unreliable. Place tees or crosses at the bend of both pipes from boiler to water column; remove the plugs and clean these pipes when washing out boiler.

7. In case of foaming, close the throttle long enough to show the true water level in boiler. If the level is sufficiently high, feeding and blowing down will usually correct the evil. If foaming becomes violent, check the draft and use surface blowoff freely. Ascertain the cause of the foaming, and take the necessary steps to prevent the evil.

8. In case of low water, cover the fire with wet ash, or with green fuel if wet ash is not available, and close the fire and ash pit doors. Don't touch the safety valve. Don't turn on the feed water under any circumstances. Let the steam outlets remain as they are until the boiler has been cooled off and examined to determine what damage has been done.

9. When connecting boilers, exercise great care. See that the pressures on the steam gages agree before attempting to open the steam valves. Open the valves very slowly, and, if provided with small bypass valves use these before opening the large valves. Never connect boilers unless the steam pressures agree. Many explosions have been caused by neglect of these precautions.

10. Do not close the damper entirely when there is fire on the grates, as gas may collect and result in an explosion as destructive of property as a boiler explosion.

11. Provide a V-shaped brick pier or asbestos cover to protect the blowoff pipe from direct flame in furnace. Have this pipe extra heavy with malleable elbow. Once or twice a day blow down about 2 in. of water. The best times to use the blowoff are the first thing in the morning and directly after the noon hour, on each occasion before starting up; the circulation has then been retarded for some time and the scale-forming matter has had opportunity to settle near the blowoff. Open and close blowoff cock slowly to avoid water hammer.

12. Keep the boiler dry on the outside, as moisture will cause external corrosion.

13. Keep the brickwork tight so that cold air does not enter, as it will cause fuel losses. Fire lightly and frequently and endeavor by all means to save fuel for your employer. Endeavor to carry a uniform water level when boiler is in service. Keep the feed pumps, injectors, and all other appliances in good working order and as neat as possible.

14. Wash out the boiler at least once every month and more often if feed water is bad. Do not allow mud or scale to accumulate in boiler and do not allow oil or grease to enter boiler; these foreign substances may cause overheating and burning of plates and result in a bag, rupture, or violent explosion. A solution of soda ash or a small quantity of kerosene fed continuously into boiler is often beneficial in preventing or softening scale; when these substances are used open blowoff cock once or twice a day as in rule 11. If kerosene is used, great care must be exercised to see that it is entirely gotten rid of by allowing a draft to blow through the boiler before bringing a naked light to the boiler or allowing any one to enter the boiler, as an explosion may ensue or the fumes may overcome the person entering.

15. When a boiler is to be cleaned, allow the fire to die out, and leave the dampers open with fire doors closed for at least 12 hr., when the steam gage should indicate no pressure. Then admit air on top, open blowoff cock, and allow the water to run out. Remove the upper manhole plate, and use vigorously a large hose with ample water pressure to dislodge loose scale, and wash out the boiler thoroughly. Now remove the lower manhole plate and all the handhole plates, and entering the boiler, remove the lodged scale at the turn of the flanges and below and between the tubes. See that all parts of the boiler are entirely free of scale and clean internally and externally from head to head, and see that the furnace is cleaned out from end to end. Examine carefully all parts of the boiler for defects, particularly the parts that are subjected to the direct heat of the furnace. See that any leakage at tube ends, or elsewhere, is stopped immediately, and that any tubes found bagged, or any other defects, are repaired at once.

16. Have all steam gages tested by the inspector. The gages should be placed on siphons and attached so that they may be readily taken down for test.

17. The inspection of a steam boiler is a matter of vital importance. When notified to prepare a boiler for internal inspection, proceed to cool down and clean the boiler as per instructions given. Remove all scale, clean out the ash and soot on the grates and in the combustion chambers, and sweep off the plates, heads, and tubes, so that every part of the boiler may be examined and its exact condition determined. Have the boiler cool for the inspector when he arrives. Have the steam gage ready for testing, water column connections open for inspection, and everything in readiness to facilitate a thoroughgoing inspection of the boiler and all its connections. Careful compliance with this rule will protect your employer's interests and your own also.

For low-pressure steam and hot water boilers the same rules apply in general, but special instructions are given as follows:

In the case of cast-iron boilers look out for cracks also in the daily inspection.

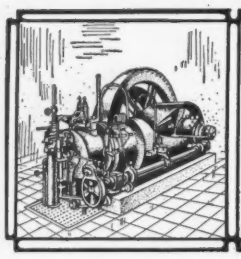
18. First, last, and always, be careful that you have the proper amount of water in the boilers when in service. DON'T fail in this. DON'T permit the water to get low. DON'T depend on the automatic water feeder. See to it yourself that the boiler gets the proper amount of water. DON'T fill an empty boiler with water when there is a fire in the furnace or when the furnace walls are hot. DON'T let any one else do this. REMEMBER that water coming into contact with hot metal will crack the metal. DON'T permit any person to draw water from the boiler when there is a fire under it. Your personal safety and the safety of the boiler requires strict observance of this RULE.

19. In cleaning boilers, allow the fire to die out and the pressure to run down to zero. Admit air on top, take off the plates and use the hose thoroughly, then clean out all remaining scale. Examine all available parts and have defects repaired. If grease gets into the boiler, use sal soda to neutralize it, and see that the grease is kept out thereafter. It is dangerous to have grease in a boiler; dangerous to the boiler and dangerous to your personal safety.

20. In the case of hot water heating boilers, the steam gage shows the height of water in the system in pounds pressure. Before starting up, go to the expansion tank under the roof and see that the water is at the correct height in the tank. Then return to the boiler and make a mark with red paint on the steam gage where the needle stands. Use this mark as a guide in filling boiler when necessary. The needle should always stand at this mark when the boiler is in service. Some boilers are provided with altitude gages similar to steam gages; if provided, their correctness should be tested in the same manner as the steam gages by noting their readings when the water is at the correct height in the expansion tank. In hot water systems no valves should be allowed in the pipes leading to or from the boiler and heating system, except radiatory valves. If such valves are in have them removed, for if the valves are inadvertently closed an explosion will occur. An explosion of a hot water heating boiler will also occur if it is not directly open to the atmosphere through the expansion tank; it is your duty to trace out the pipe line from boiler to tank and KNOW that it is open and safe. No safety valves are required on hot water boilers open to the atmosphere through the expansion tank. Insist on gage cocks and water glass being provided for the boiler as a safeguard.

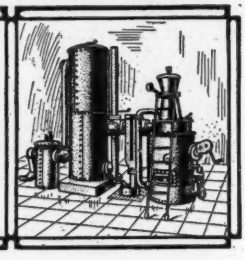
21. When the heating season is over, it is important that the boiler be properly cared for in order to prevent internal and external corrosion. Remove all the ash from the furnace and combustion-chamber, and sweep clean all parts of the boiler in contact with the heat of the fire. Get some linseed oil and paint all surfaces exposed to the heat of the fire. Then let the water out and remove all scale, mud, and sediment. If the boiler is in a basement and dampness exists, put 2 to 5 lb. of sal soda in the boiler, close manheads, and fill up with water to ordinary level. If boiler is in a dry place, leave it open to the air after cleaning. In the case of steam heating boilers the radiators and pipes should be well drained and left empty of water. In the case of hot water heating boilers, clean as above directed and lay up with the boiler and system filled with water, using sal soda to prevent internal corrosion. When the boiler is empty, go over the radiator valves and repack the glands, using well oiled packing. Observance of this rule will prolong the life of the boiler and plant and reduce repair bills.

IRREGULARITY AND NEGLECT breed inefficiency of operation.



Gas Power Apparatus

Producers, Engines and Industrial Applications



ESTIMATING THE HORSEPOWER OF A GAS ENGINE

By C. C. Winn

IN estimating the horsepower of a gas engine it is rather a simple matter to assume a mean effective pressure appropriate to quality of gas used, and together with the area of the piston and stroke and revolutions per minute of the engine, substitute in the formula: PLAN÷33,000. Since, however, the mean effective pressure depends upon so many component factors, which in turn, depend upon the judgment of the designer, it would be a difficult matter to estimate its value with any degree of accuracy. It therefore becomes necessary to employ another method, which is based upon an assumption of thermal efficiency, and the quality of the explosive mixture. This assumption is more likely to be correct than one of mean effective pressure.

The work done by a heat engine is equal to the difference between the heat supplied to the engine and the heat rejected. In the Otto cycle, the work done per cycle is:

$$W=(S-R)\text{B.t.u.}=778\ (S-R)\text{ foot pounds.}$$

Where: W=Work done per cycle.
S=Heat supplied.
R=Heat rejected.
B.t.u.=British thermal units.

The efficiency of the cycle, $E=W\div S=\frac{S-R}{S}$

Substituting E for $\frac{S-R}{S}$ in our formula for work, we have: $W=778\times E\times S$ foot pounds.

Let V=Piston displacement in cubic feet, let H=caloric value of fuel per cubic foot in B.t.u., and let the explosive mixture consist of (r) parts air and 1 part gas. The volume of fuel supplied during each admission is

$V\times\frac{1}{r+1}$. The heat of combustion of this charge would be $S=V\times\frac{H}{r+1}$ B.t.u.

Substituting for S in our formula for work, we have

$$W=778\times E\times V\times\frac{H}{r+1}\text{ foot pounds.}$$

$$\text{But horsepower}=\frac{W\times\text{C. P. M.}}{33{,}000}$$

Where C. P. M.=Cycles per minute.

And since an engine working on the Otto cycle requires 2 revolutions to complete a cycle, our formula for horsepower becomes

$$\text{B.HP.}=778\times E\times V\times\frac{H}{r+1}\times\frac{\text{R.P.M.}}{2}\div 33{,}000.$$

Where B.HP.=Brake horsepower.

Value V is in cubic feet, and is equal to

$$\frac{3.1416\times D^2}{4}\times L$$

Where D=Bore of cylinder in feet.
L=Stroke of piston in feet.

TABLE OF COMMERCIAL POWER GASES

	GAS	H LOWER HEATING VALUE B.T.U. PER CU. FT.	r VOLUME OF AIR REQUIRED CU. FT. PER CU. FT.	H÷(r+1) TRUE EXPLOSIVE MIXTURE B.T.U. PER CU. FT.	E EFFICIENCY OF ENGINE WHEN NOMINAL BRAKE-HORSE POWER=						
					5	10	25	50	100	250	500
SUCTION PRODUCER	LEAN	305	7.5	38.2	20	22	24	26	27	27	27.5
	AVERAGE	600	9	60.	20	22	24	26	27	27	27.5
	RICH	675	10	61.3	20	22	24	26	27	27	27.5
	ANTHRACITE	144	1.15	66.9	17	19	21	23	24	25	25
	BITUMINOUS	144	1.25	64	17	19	21	23	24	25	25
	COKE	125	1.	62.5	17	19	21	23	24	25	25
	NATURAL	978	9.73	91	21	23	25	26	27	27	28
	BLAST FURN.	106	1.1	50.5	16	18	20	22	24	24.5	25
	COKE OVEN	603	5.6	91	15	17	19	21	23	25	26
	WATER	295	2.35	88	13	17	19	21	22	23	24
	CRUDE OIL	846	8.07	93	25	26	27	29	31.5	32	32.5

Substituting this value of V in our formula for horsepower, and canceling, we get

$$\text{B.HP.}=0.00000536\times E\times D^2\times L\times\frac{H}{r+1}\times\text{R.P.M.}$$

(D and L are here expressed in inches.)

The value for D, L and R.P.M. are determined from the engine. This leaves the values for E and $\frac{H}{r+1}$ to be determined.

As a result of a number of engine tests, and analyses of the gases used, average values for E, H, and r have been computed. Column 1 of the accompanying table, contains the ordinary commercial gases. Column 2 contains the lower heating value of each gas, and column 3, the ratio of air to gas by volume. In column 4 the value of the true explosive mixture $\left(\frac{H}{r+1}\right)$ is tabulated. It will be noted that r is not the theoretical ratio, but allows of excess air. This is merely an average value which experience seems to prove necessary. The remainder of the table gives the average thermal brake efficiency of engines from 5 to 500 hp., for each gas tabulated. These values have been calculated for 4 stroke cycle engines only. For 2 stroke cycle engines the result should be multiplied

by 2. For more refined calculations, however, a constant of 1.6 should be used. This latter value considers the lower efficiency of the modern 2 stroke cycle engine.

For double acting engines, the computed horsepower should be multiplied by a constant varying from 1.88 in small engines to 1.76 in relatively large engines. These constants make an allowance for the space neutralized by the piston and tail rods of 6 per cent in the smaller sizes and 12 per cent in the larger sizes.

Examples

A TWO cylinder, double acting natural gas engine, with cylinders 18 by 22 in. is rated at 350 b.hp. when running at 200 revolutions per minute. The estimated horsepower is

$0.00000536 \times (18)^2 \times 22 \times 0.27 \times 91 \times 200 \times 1.88 = 352.8$ b.hp.

A 10 by 15.7 in. single cylinder illuminating gas engine, of the single acting type is rated at 20 b.hp., at a speed of 210.7 revolutions per minutes. The estimated horsepower would be

$0.00000536 \times (10)^2 \times 15.7 \times 210.7 \times 0.24 \times 60 = 22.3$ b.hp.

A 44 by 60 in. twin tandem gas engine using anthracite producer gas, is rated at 4200 b.hp., when running at 100 r.p.m. The estimated output is $0.00000536 \times (44)^2 \times 60 \times 100 \times 0.25 \times 66.9 \times 4 = 4205.24$ b.hp.

A single cylinder, 4 cycle gas engine, with cylinders 16.95 by 27.5 in., is rated at 60 b.h.p., when operating on blast furnace gas, and running at 160.6 r.p.m. This engine developed on test, 54.5 b.hp. under those conditions. The estimated horsepower is, $0.00000536 \times (16.95)^2 \times 27.5 \times 160.6 \times 0.22 \times 50.5 = 57.3$ b.hp.

These are merely examples taken at random, and although they prove the usefulness of this method, it is not to be assumed that the results will be as accurate in the majority of cases. The values assumed are only average values, and when substituted in the horsepower formula would give the horsepower of the average engine operating under a fixed set of conditions.

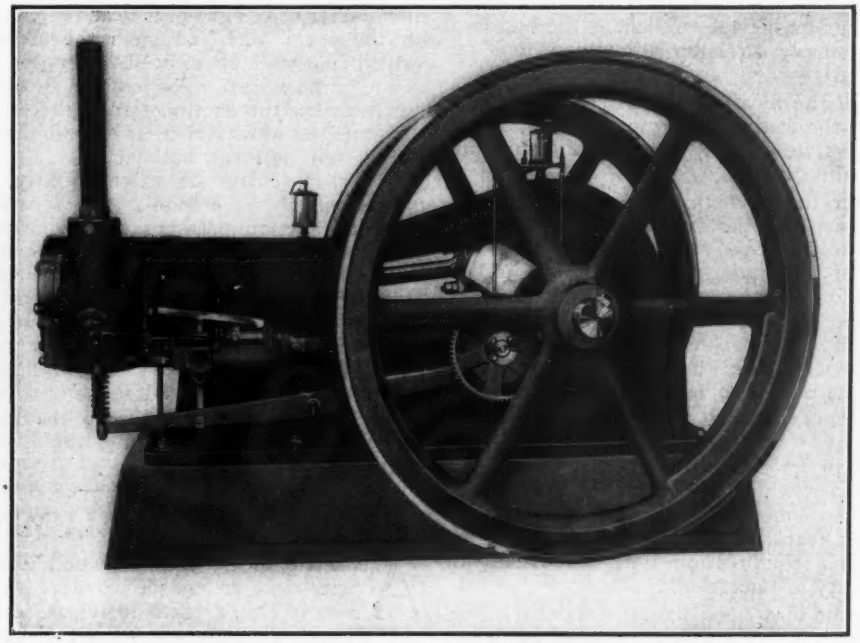
THE NEW CHARTER GAS ENGINE

TO meet the demand for a heavier power engine of the horizontal single-cylinder type, that will run economically, continuously and smoothly, the Charter Gas Engine Co. of Sterling, Ill., has placed on the market a new style of from 60 to 100 hp.

While the main working parts do not differ except in size from those of a 20 or 30-hp. engine, a number of refinements of the large producer-gas engines that add to the successful operation and which the engineer will fully appreciate have been added.

The illustration is from a photograph of an 80-hp. engine and following is a brief description of the features of this type.

Made extra heavy and strengthened by ribs at points of greatest stress, the bed has a wide oil trough extending around the base, which adds stiffness as well as gathering waste oil and carrying it to a convenient drain pipe. At the crank end, the housing carrying the main bearings is greatly stiffened by bringing the end of the bed and the apron up to a line even with the center of the crank shaft, by this means preventing springing of the main bearings with a minimum weight.



THE NEW CHARTER GAS ENGINE 60 TO 100 HP.

Main bearings are half cylindrical machined shells, divided at 45 degrees with the line of explosion pressure; oil grooves on the outer ends prevent oil working out on to the flywheels. The lower half bearing can be removed by jacking up the end of the crank shaft slightly and revolving the shell out of its place.

Connecting rod brasses are easily taken up in the event of wear; the crank end by means of liners, the piston end by wedge and bolt adjustment.

A substantial crank shield carrying a sight oil reservoir of ample capacity covers the crank shaft, connecting rod and open end of the cylinder. Oil tubes with sight feed adjustment lead to the main bearings, crank pin and gear pin bearings. To allow

the use of 2 grades of lubricating oil, a separate sight feed cylinder oiler is usually provided.

Inlet and exhaust valves, of the vertical poppet type, are both mechanically operated, positive operation of the inlet or suction valve being an important factor in securing the maximum power, economy and smoothness of operation. The exhaust valve is operated by a cam on the gear shaft which carries also an eccentric for operating the inlet valve, igniter, fuel and water pumps.

Vertical valves are used in both circulating water and fuel pumps; these can be inspected, cleaned or renewed by removing a cover on the side of the respective valve chambers. Circulating water is forced by the pump into the exhaust case, where the coolest water is needed for properly cooling the exhaust valve and stem. From the exhaust case the water goes through the cylinder water jacket and out.

The igniter is of the make and break type, has adjustment to take up wear on the points, and is removable by loosening 2 nuts. Either electrode is removable by means of a bicycle wrench, as there are no taper pins, but simply a clamp adjustment on the movable electrode.

On the hub of the flywheel is carried the hit and miss governor of the centrifugal type, which operates on the exhaust valve, cutting out the fuel and air charges except when needed.

Vertically over the inlet valve the liquid fuel injector is placed so that the fuel spray drops down to the combustion chamber. There is therefore positively a charge of fuel taken whenever it is injected into the inlet valve by whatever means, for the mechanical lifting of this valve allows it to drop in of itself. This is of considerable help in starting. A feature of this device is that the liquid is throttled or regulated, not by a needle valve a short distance back of the point of spray, but at the very point of its spraying into the downward rushing column of air.

A water injector for the introduction with the fuel of a fine jet of water, which has the effect of moderating the explosion to more of the expansion type, is another important feature in the successful operation, allowing of higher compression with its attendant economy and surety of operation.

Special attention has been paid to making these engines easy starting. A quickly manipulated lever for throwing into action a compression relief cam, and another for changing from early to late spark greatly relieve the drudgery of starting. While all Charters are regularly equipped with self starting pump and match striker, with which one man can easily start the largest engine, it is possible for one man alone taking advantage of the compression relief and late spark, to start by pulling on the wheels.

All the working mechanism is on the one side in easy reach of the operator, with no rods or pipes inside the bed of the engine.

The guarantee covers the rated power of the engines, fuel consumption of 0.1 gal. per horsepower-hour, and free replacement of defective parts for one year.

As given in The Locomotive, the boiler explosions for 1909 were 550 in number, accompanied by 227 deaths and 422 persons injured. These explosions are about in proportion to the industrial use of steam power in the country. Vermont is the only state enjoying the distinction of having had no boiler explosions during the year.

ADJUSTING THE AIR AND GAS MIXTURE

A TROUBLESOME point for many new producer gas engine operators is how to proportion the ratio of air to gas for the most economical operation of the plant. This is due to the fact that the ratio is adjusted by running the gas valve wide open and throttling the supply of air, instead of leaving the air valve open and throttling the fuel, as is the case with engines using artificial or natural gas or gasoline as fuel.

This ratio is usually obtained by setting the air valve at a point where the engine carries the load and letting it go at that, but this method is inaccurate and liable to give too rich a mixture, resulting in a serious waste and more serious producer troubles if the producer be slightly too small for the engine.

A convenient and accurate method is to attach a manometer to the gas pipe near the engine. Then put on the usual load and open the air valve, the gas valve being wide open, until the engine begins to slow down or backfires. The engine is then drawing so much air on the suction stroke that it may backfire, preignite, or slow down, or do all three, but at any rate it will not run satisfactorily.

Then close the air valve slightly, enriching the mixture until the engine operates satisfactorily, and note the suction pressure on the manometer. This pressure indicates the point to which the air valve should be opened when the engine is carrying this load with a constant quality of gas. If the load changes during the day, the air valve setting can be changed to meet the conditions in a very short time, and the operator is aways certain that his engine is operating economically. Be careful to keep the manometer full of water, otherwise the mixture will be weakened by drawing air into the system.—The Gas Engine.

SOLDERING ALUMINUM

AMONG solders most commonly used for this work with more or less success, are:

5 parts zinc, 2 parts tin, 1 part lead.

9 parts zinc, 100 parts tin, 165 parts lead.

46 parts zinc, 2 parts tin, 52 parts copper.

10 parts zinc, 100 parts tin, 20 parts silver, 1 to 6 parts aluminum.

70 parts aluminum, 20 parts tin, 10 parts copper or silver.

30 parts aluminum, 20 parts copper, 50 parts zinc.

12 parts aluminum, 8 parts copper, 80 parts zinc.

6 parts alumium, 4 parts copper, 90 parts zinc.

5 parts zinc, 95 parts tin.

With the last five the surfaces should be first tinned. The use of good flux, such as borax, is generally desirable. Quite a number of solders and processes that are trade secrets are now being exploited in the market, some of these being quite satisfactory.

Many authorities recommend that the parts be first tinned with an alloy 1 part alumium to 5 parts tin, to prevent the film of aluminum oxide that forms on the surface of pure aluminum, and which is the cause of the difficulty in soldering this metal.

Selling goods by demonstration is the most successful policy known. When buying apparatus visit some plant where a demonstration is going on every day.

THE MINE ENGINEER

By Jas. C. Stewart

EARLY mine engineers' licenses in Illinois consisted of certificates issued on merit and ability to those from 18 yr. of age up, who had the required experience around mines, while now the minimum age is 21 yr. The examination consists of written and oral questions. The written examination consists of questions pertaining to size cylinders required for certain loads, size of drums for certain size cylinders, safety-valve formulas, breaking strain of ropes, etc. The oral examination consists of questions pertaining to engines and boilers in general.

Some of the larger mines have a machinist or a master mechanic to look after the machinery while others leave it all to the engine men. At some mines the great difficulty is lack of water and at others to get rid of the excess. I fired at one mine where it had to shut down because the water was such a detriment and expense. We had to have too many pumps to keep it down and men to take care of them. They furnished the poorest grade of coal to fire with, had a man to shovel it in from the cars and a man with mule and cart to haul the ash away. I have often cleaned fires 10 times a day and received $1.50 per day of 10 hr.

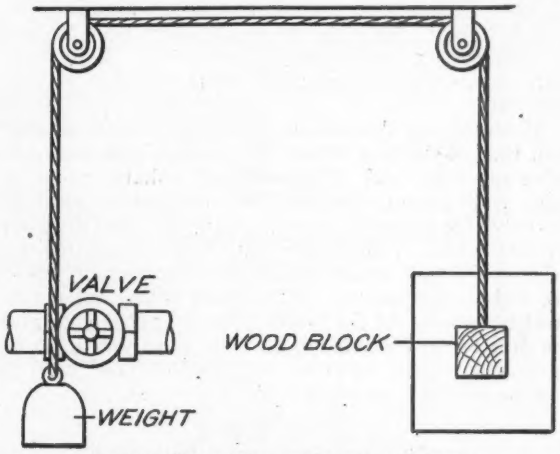
I next ran at a mine so dry that we had to get the waste water from the city artesian wells for the boilers, agreeing to keep 60 lb. pressure in the city hydrants, this we did with a regulating arrangement as shown in the illustration. We hung a float on a rope over 2 pulleys and when the well was full this float, a block of wood, would rise with the water, and we put a large wheel on the steam valve of the pump and hung a weight on it which would open the valve and when the water was lowered the block would go down and in so doing would close valve.

The engineer's duty is to keep things going, have the engines in shape to hoist the coal rapidly in order to keep all the men working, and have no delays on account of machinery. They have large engines now on the first motion, from 14 by 24 in. with a 4-ft. drum to 24 by 36 in. with a 10-ft. drum owing to the size of mine car and depth of mine. The output of mines varies from 800 to 2000 tons a day and the capacity of the mine car varies from 1500 to 5000 lb. Most mines have self dumping cages which, when up, strike a block which tips them and unloads the contents into a tipple where it is weighed. The engineer must take up the slack in the ropes and adjust them so that when 1 cage is on top the other will be at the bottom with no slack in the ropes.

The engineer has quite a responsible position at coal mines from the fact that state laws are very rigid with coal mines now as they hoist coal fast. State inspectors take note of conditions and will shut mines down that do not comply with the law, and I must state that it is a good thing in all respects. The engineer now works 8-hr. shifts in Illinois, due to the influence of the law requiring a state certificate of competency, and coal companies appreciate the services of a trustworthy engineer.

There are 3 shifts in 24 hr., the engineers being paid $90, $85 and $78 a month, according to the size and capacity of mines. The engineer must hoist rapidly and stay right in the engine room while hoisting coal so as to keep all men going. Some mines have from 200 to 400 miners. At a mine, producing 1000 tons in 8 hr. with mine cars of 1500 lb. capacity, one can see how busy the engineer must be. Yet the Diamond mine in Grundy Co. once in 10 hr. put out 2060 tons with the capacity of mine cars from 1500 to 2000 lb. At that time it was considered the best output in any mine in Illinois, this being about 16 or 17 yr. ago.

In Will and Grundy Cos., where I worked, it is not deep to the coal, 120 ft. below surface; we used 4 and 5-ft drums as the capacity of cars is only 1500 to 2000 lb. and 12 to 24 revolutions of the engine brings the cage up, while in mines of 500-ft. depth, such as Bloomington and Centralia, they use 8 and 10-ft. drums with engines 24 by 36 in. and in from 18 to 20



PUMP REGULATOR USED IN A MINE

revolutions of the engine the load will be hoisted, for with this size drum every revolution of the engine hoists the load 30 ft.

There is no limit to the speed in hoisting coal but the law will not allow men to be hoisted or lowered at a speed greater than 600 ft. a min. Should an engineer hurt a man the law may take him in hand. I have known of the state inspector ordering a coal company to remove an engineer on account of the way he hoisted miners.

The duty of the safety catches is to hold the cage should the rope break, in this case it will sink the catches into the slides and hold the cage. At mines where no machinist is employed it is the engineer's duty to see that the fan engine also is in shape and for this purpose he arranges to do the necessary work on idle days, holidays and Sundays. He arranges for washouts at these times, but when too busy he arranges for this to be done at night when the other man relieves him.

The most particular duty of the engineer is to watch the ropes and if there is any strand broken he must notify the bell man at the bottom and the top men not to allow any men to ride in this cage till a new rope is put in. The engineer must thoroughly examine the machinery when going off duty and fill out blanks at most mines. The top man examines the cages and safety catches and must also sign this book before the men go down in the morning.

Also the fire boss and night manager should sign the book as to condition of the mine and gas, etc., before the men are permitted to go down in the morning, thus fulfilling a requirement of the law.

When a gage glass breaks, to avoid being scalded shut off the water first, then the steam.

VALVE DIAGRAMS

DESIGN AND LAYOUT OF A D VALVE

METHOD of design is easiest shown by an actual problem; therefore, take the case of a 10 by 16-in. engine with connecting rod 32 in. long to run at 200 r.p.m., cut off at 5/8 stroke, release at 93 per cent of stroke, lead 3/32 in. Lead and compression to be equalized. Required the valve design and steam connections.

Steam Velocity

WE will assume that in accordance with good practice the steam velocity in the live steam pipe is to be 8000 ft. a min., through the steam ports 6000 ft. and through exhaust ports and pipe 4000 ft. Length of ports across the cylinder to be made 0.75 the cylinder diameter.

Evidently, as the exhaust steam velocity is smaller than that of the live steam, the ports which in the D valve serve for both admission and exhaust must be made wide enough for exhaust; the port opening by the valve for the admission of steam can then be made 2/3 the width of the port, and the port opening for exhaust the full width of the port. As the port opening will be unequal for the 2 ends of the cylinder, care must be taken that the smaller one is sufficient to give the desired steam velocity; a less velocity will do no harm, but higher velocity will increase the drop in passing through the ports.

Port Sizes

IT is considered that the cylinder must be filled with steam each stroke. This is not, of course, actually to flow in as fast as it would if the cylinder were filled, and in exhausting, the cylinder full of steam has to be discharged. The volume of steam per stroke is, therefore, the piston area, which for a 10-in. piston is 78.54 sq. in. times the stroke, 16 in.; and the volume per minute will be this times the strokes per minute or 400. This gives,

$78.54 \times 16 \times 400 = 502{,}656$ cu. in. a minute.

For the steam pipe the velocity is 8000 ft. or 96,000 in. a minute, so that the area must be $502{,}656 \div 96{,}000 = 5.235$ sq. in. From a table of pipe dimensions this is found to be too large for 2½-in. pipe, hence 3-in. should be used.

For the steam ports openings, the velocity is 6000 ft. or 72,000 in. a minute and $502{,}656 \div 72{,}000 = 6.981$ sq. in. As the port is to be $0.8 \times 10 = 8$ in. long, the opening by the valve must be $6.98 \div 8 = 0.875$ in. or 7/8 in.

Exhaust openings will be $502{,}656 \div 48{,}000 = 10.472$ sq. in. area which calls for port opening $10.472 \div 8 = 1.309$ in. and 4-in. exhaust pipe. Using 1 3/8-in for port opening will give some leeway in the design.

The Design

FIRST determine the known crank positions for cut-off, head end, and for release by laying out the cross-head positions and with the connecting rod length striking arcs to intersect the crank circle. Draw the crank lines for these positions and from O strike arcs with the port openings required as radii.

We have seen that cutoff cannot be the same for crank end as for head end, since lead is to be equal, which requires equal laps; also equalized compression will call for unequal exhaust laps and release will not be the same for the 2 ends.

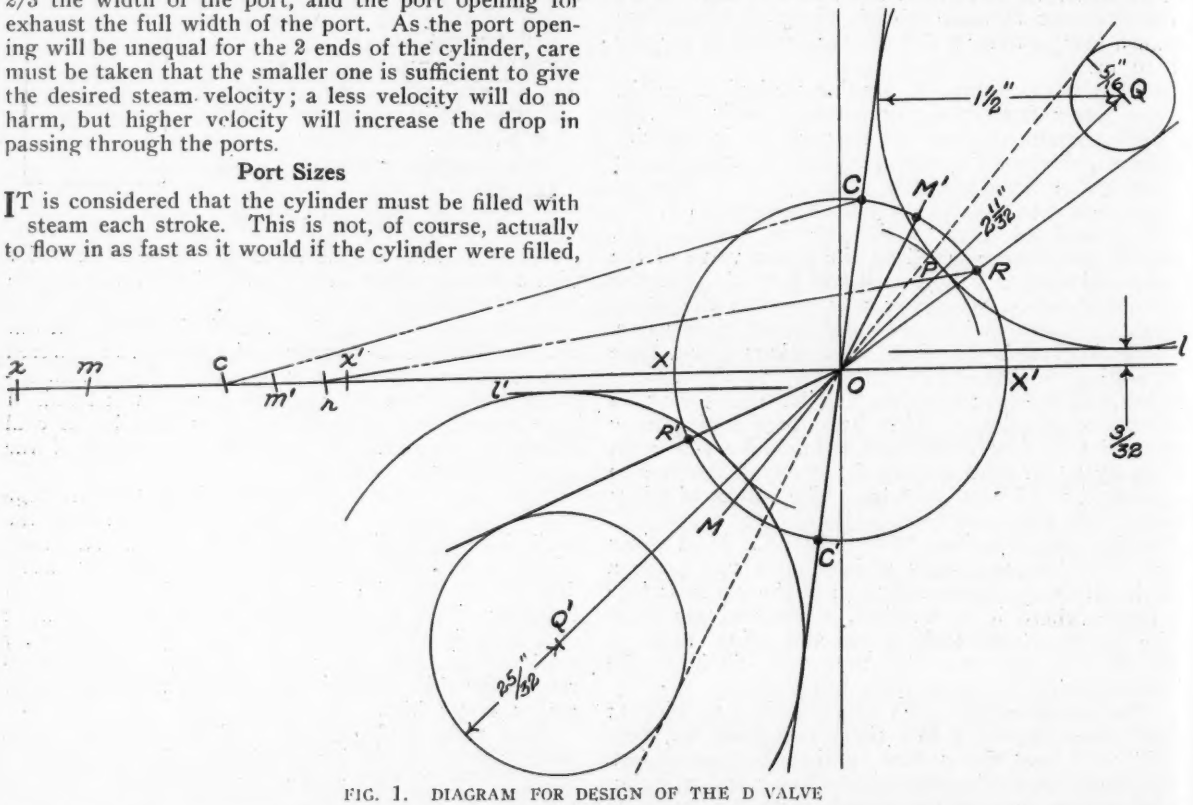


FIG. 1. DIAGRAM FOR DESIGN OF THE D VALVE

Lay off lead for each end 3/32 in., above the center line for the head end and below for the crank end. We then have to find by trial a circle which will come tangent to the cutoff crank line, the lead line and maximum steam port opening line, and the position of its center locates the eccentric center, while its radius is the steam lap.

From that center a circle tangent to the compression crank line gives the exhaust lap for head end and from the position of the center on the other side

of O the crank end exhaust lap is found in like manner.

Measuring on the diagram it is found that the valves are for steam lap 1.5 in., for eccentricity, 2 11/32 in., for exhaust lap head end 5/16 in., crank end 25/32 in.

The process of the diagram is as follows: Draw the line of centers, the crank circle from O as center and crosshead path xx′ to ⅛ size. Lay off c at ⅝ stroke from x, and with radius 32 in. to scale locate C. Draw l at 3/32 in. above the center line xx′ and draw arc P with radius ⅞ in. By trial find center Q and radius QP, which gives an arc tangent to OC, 1 and P.

Lay out r at 0.93 stroke from x and locate R; draw crank line OR and circle from Q tangent to it. Then MO is compression crank line and M is crank position at head end compression, from which locate m. As compressions are to be equalized, xm=x′m′, and from m′, M′ is located, giving M′O, which determines the crank end exhaust lap. Steam lap is the same for the 2 ends since lead is equal.

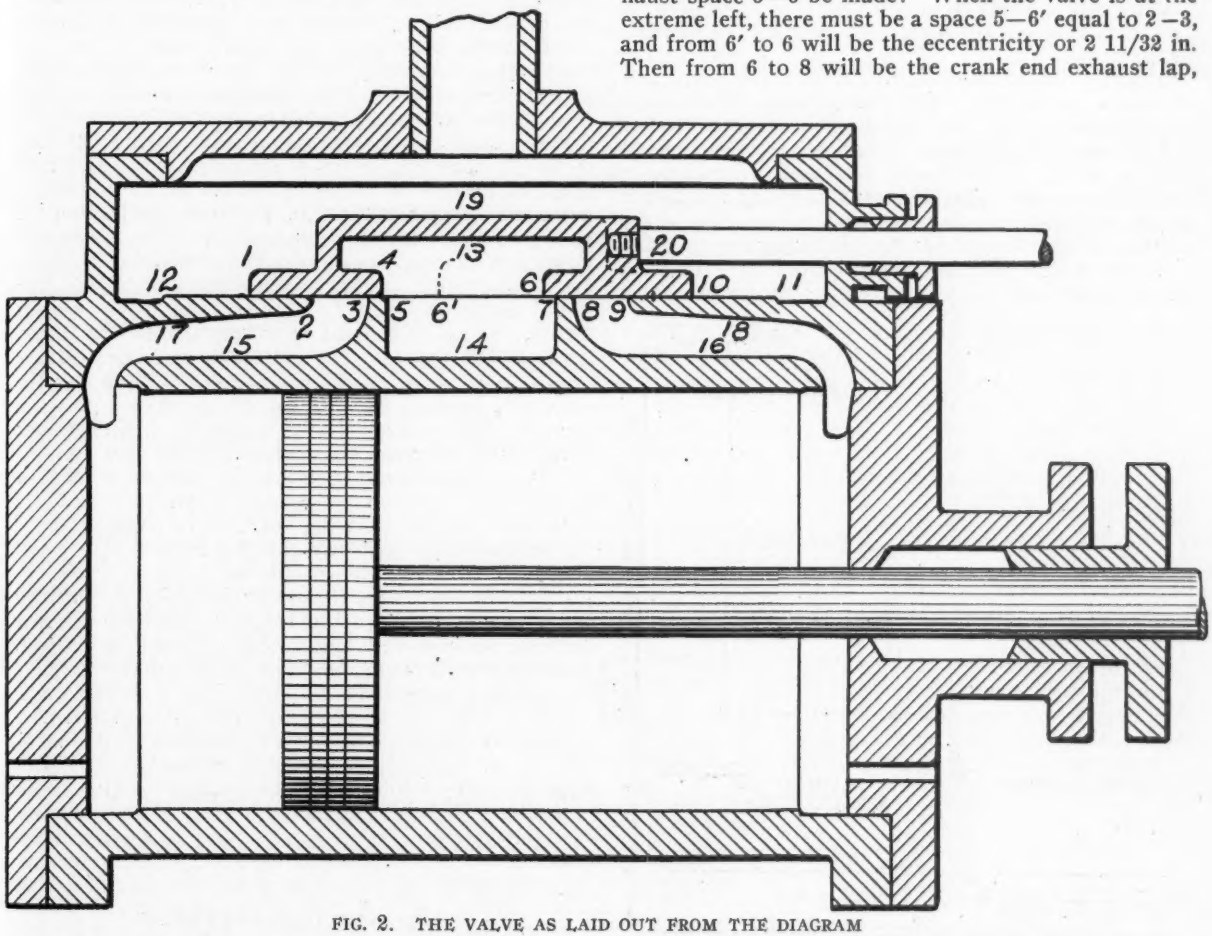


FIG. 2. THE VALVE AS LAID OUT FROM THE DIAGRAM

Laying Out the Valve

BEGINNING at the left of Fig. 2, a line is drawn which represents both the working face of the valve and the valve seat. The drawing is ¼ size. With 1 as the head end of the valve, the steam lap, 1.5 in. is laid off to the right giving point 2; next from 2 the width of the port 1⅜ in., giving 3. The bridge between the port and the exhaust space must be wide enough to prevent steam leakage and ⅜ in. will be safe; laying this off from 3 gives 5.

Exhaust lap at the head end is 5/16 in. and is laid off from 3, giving 4. If the thickness of metal be taken at ½ in. the head end of the valve may now be shaped up according to the designer's best judgment. From valve face to line 13 the distance should be equal to 2—3; also from seat to 14, the same distance.

Lines 15 and 17 may approach each other going towards the end of the cylinder as the ports will be spread and curved to enter the counterbore.

Next arises the question—how long shall the exhaust space 5—6 be made? When the valve is at the extreme left, there must be a space 5—6′ equal to 2—3, and from 6′ to 6 will be the eccentricity or 2 11/32 in. Then from 6 to 8 will be the crank end exhaust lap, 25/32 in., giving the port edge of the bridge at 8, and 8—7 will be ⅜ in. the same as 3—5.

From 8 to 9 is the port opening 1⅜ in. and 9—10 is the steam lap, 1.5 in., which gives the completed valve.

At the ends, the seat should extend beyond the valve ends a little less than the eccentricity to give overtravel and avoid wearing a ridge. As the eccentricity is 2 11/32 in. the seat, 1—12 and 10—11 may be made 2¼ in. long. The rest of the detail depends upon the strength required to carry the steam pressure and the ideas of the designer.

Examination of Fig. 2 will show that the total seat length is 15¼ in., which is rather large for this size of cylinder. If it be desired to shorten the valve in order to cut down the area subject to pressure, the velocity through ports can be increased and the port opening reduced as much as in the designer's judgment is allowable.

SHUTTING DOWN

LOCATING AND REPAIRING DEFECTS IN ICE MAKING MACHINERY

By Wm S. Luckenbach

ALL the pumps should be carefully examined and thoroughly repaired, especially so if steam driven. Before dismantling, the steam pistons and slide should be tested for leaks with steam pressure, as it may be that the slide valves are tight and it will simply be wasting time to take it for granted that they needed refacing when probably they may be found tight if the test is made; this can be done in less than an hour for each pump.

If the cylinder is straight, the principal part will be to put the piston in first-class shape. The piston may be smaller than the cylinder by reason of having been rebored, which makes it difficult to keep the rod packing tight. This can be remedied by making a new follower the right size, thus carrying the piston central and also avoiding slamming. Leave no sharp corners on the follower for fear of cutting the cylinder.

If the water is being pumped from river or well, see that the foot valve is all right; do not guess at

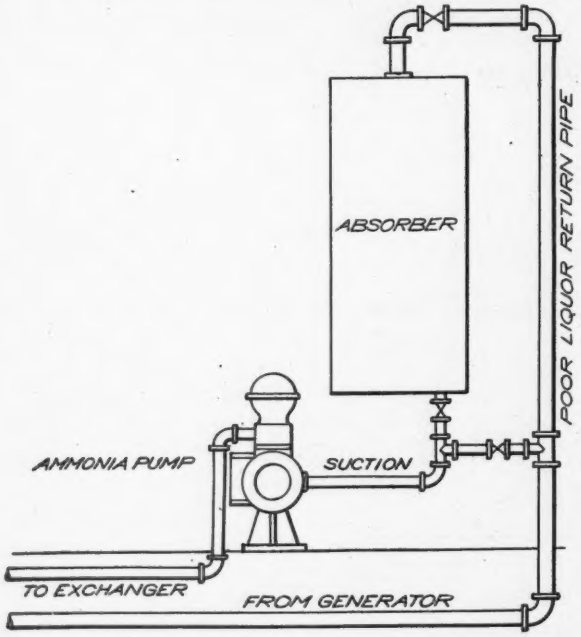


FIG. 1. PUMP PIPED TO AVOID GAS BINDING

this, but get a chain block and hoist it out in the clear, or you may be mighty sorry some time next summer.

One of the most important parts of the plant is the ammonia pump, in fact all plants should have an extra pump to avoid the possibility of shutting down in case of some unforeseen accident; hence, the importance of having it in the most reliable condition possible. It occasionally happens that the pump gets gas bound; to avoid this, a good plan is to make a connection from the poor liquor return pipe near the absorber to the suction pipe with a valve between. Close the absorber suction valve, open the poor liquor valve and pump about half a minute, and the poor liquor will quickly absorb the surplus gas. Another plan is to have the suction pipe one size larger than the pump calls for, and the change can easily be made when the absorber is empty.

Condensing Coils

CONDENSING coils, whether double tube or atmospheric, must be thoroughly cleaned and kept clean in order to get the best effect of the cooling water, and if atmospheric, should be protected from the sun's rays in order to get the liquid ammonia as near the temperature of the cooling water as possible. The importance of this can be readily seen when an increase of even 3 deg. makes a decided difference in the expanded gas for taking up heat in the freezing tank. By referring to the standard table we find that at a temperature of 70 deg. F. one cubic foot of liquid ammonia weighs 37.230 lb. and one cubic foot of saturated ammonia vapor weighs 0.4401 lb., hence the expansion of the liquid into vapor will be 37.230÷0.4401=84 times, and at a temperature of 73 deg. the liquid ammonia weighs 37.099 and the vapor weighs 0.4645, and the expansion is 37.099÷0.4645=79 times. Thus it will be seen that increasing the temperature even 3 deg., which cannot be detected by grasping the pipe, will decrease its heat absorbing qualities nearly 6 per cent, thus showing the importance of a thermometer being inserted near the expansion valve. It also shows the engineer at a glance what the effect will be if he doesn't get that temperature down to normal by cleaning his coils or using more water; neither need he wait until the bath has gone up several points and then wonder where the trouble is.

If there are no split pipes or special leaky fittings on the coils, they will be in good order for another season; if, however, slight leaks should develop at some of the threads they can be effectually stopped by using a split collar as illustrated. A pattern is made to conform to the pipe and split as shown at A and allowance made for 2 rubbers as shown at B. When the 2 halves are on the pipe and loosely bolted together, the rubber rings are placed in the recess and clamped tight against both ends of the coupling without straining the threads, the same appliance suitable for return bends is shown at C, they are cast iron, are inexpensive and invaluable in case of a leak.

Freezing Tank and Coils

WE will suppose that the coils need overhauling and this should be done expeditiously because these coils should be submerged again as soon as possible to prevent rusting. First in order is emptying the tank and cleaning it; be sure to include the lids and timbers that the lids rest on, in the scrubbing, to prevent dirt dropping in the cans when filled with distilled water. Disconnect top and bottom manifolds, see that the standards and bolts holding the coils are all right and have no trap in the pipe; then blow out each coil separately with steam pressure and test with brine, if the weather is cold, to about 300 lb. pressure. If any leaks should develop, put in new pipe; do not patch submerged coils except in case of an emergency. If the weather is cold, finish one coil at a time; if you have compressed air, blow through with that. In reconnecting, have the nuts on the flange bolts run free, also see that the nuts do not jam into the body of the bolt before the flanges are properly tightened

and above all get the best quality sheet rubber in the market for this purpose. The coils should be divided into sections of 2 and 3, never more than 3 because there will be a more even distribution of the expanded gas, and while this is not quite so important in the flooded system yet it is of importance should one or more of the coils get clogged or spring a leak because repairs can then be made without shutting down, in fact the cost of a valve on top and bottom of each coil would be trifling compared with the loss of ammonia should one of the coils spring a leak. As to painting the coils and tank, if it is iron, there are various opinions, but one thing is clear, unless the coils and tank are thoroughly cleaned of rust, the paint will not adhere, and if by oversight a few square inches on each coil or side of tank is painted over the rust or not painted at all, the labor and material will be of little benefit. The writer has personal knowledge of bathcoils of extra heavy pipe that have been in use over 10 yr. and never had any paint on them except the cheap stuff put on at the works to prevent rust in transit, and they were tested to 300 lb. last winter.

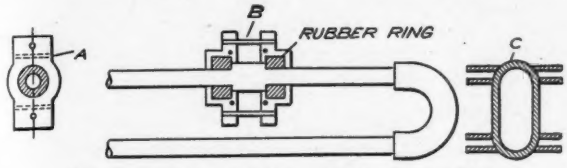


FIG. 2. SPLIT COLLARS USED TO STOP LEAK

The iron tank should, however, be kept painted wherever it is exposed to the atmosphere and moisture.

Pipe and Fittings

NOTHING but extra heavy pipe and fittings should be used on any part of the ammonia system. Do not put up a single piece of pipe or nipple without looking through it. In using a pipe cutter, it frequently happens that it not only leaves a ragged edge but reduces the area also, hence every piece should be examined. Do not use old fittings on ammonia, for 2 reasons—it costs half the price of a new fitting to clean an old one, and the threads are never as sharp and smooth as a new one.

Do not use any thick pasty substance on joint threads as it is only a question of time, and a short time at that, when the ammonia will penetrate this paste and a leak result. The writer has made thousands of joints and found that by having good threads on both pipe and fitting, using a little flake graphite with good lubricating oil and screwing up good and hard iron to iron you have a lasting job.

Adjuncts

IN addition to those mentioned for the boiler room, an automatic poor liquor regulator attached to the absorber is an excellent investment, they are sold under a guarantee and they do the work, which leaves the engineer free to do something besides watching the absorber glass. Several pounds variation in pressure in either the absorber or generator or both at the same time will require regulation by the engineer, hence he cannot leave the engine room for any length of time for fear of a boilover or flooding the absorber; on the other hand, if he can absolutely rely on a regulator, he will have ample time to devise ways and means to improve the plant in other directions that will many times repay first cost.

The back end steam flue blower is also to be considered as it not only cleans the flues without having the flue doors open at least an hour each day but keeps the boiler room free from soot.

General Appearance

THE general appearance of the plant should be made inviting for the employes, also for the owner and visitors who may occasionally make a tour of inspection, and while it is true that neither paint nor whitewash will make ice, the fact remains that a neatly kept engine and boiler room with tool racks and fittings bins lends a cheerfulness to the place, is a credit to the man in charge, and is more or less inspiring to all those connected with the plant.

CAPACITY OF AMMONIA COMPRESSORS

REFRIGERATING capacity of a compressor depends upon the number of pounds of gas it will handle in a given unit of time. The weight of ammonia gas handled depends upon the efficiency of the compressor and upon the suction pressure, or the pressure at which the gas is delivered into the compressor.

Since the weight of ammonia gas varies approxi-

TABLE I. REFRIGERATING EFFECT OF 1 CU. FT. OF AMMONIA GAS AT DIFFERENT CONDENSER AND SUCTION (BACK) PRESSURES IN B.T.U.

Temperature of Gas in Degrees F	Corresponding Suction Pressure Pounds per Square Inch	Temperature of the Liquid in Degrees F. 65°	70°	75°	80°	85°	90°	95°	100°	105°
		Corresponding Condenser Pressure (gauge) Pounds per Square Inch. 103	115	127	139	153	168	184	200	218
	G. Pres.	27.30	27.01	26.73	26.44	26.16	25.87	25.59	25.30	25.02
—27	1	33.74	33.40	33.04	32.70	32.34	31.99	31.64	31.30	30.94
—20	4	36.36	36.48	36.10	35.72	35.34	34.96	34.58	34.20	33.82
—15	6	42.28	41.84	41.41	40.97	40.54	40.10	39.67	39.23	38.80
—10	9	48.31	47.81	47.32	46.82	46.33	45.83	45.34	44.84	44.35
— 5	13	54.88	54.32	53.76	53.20	52.64	52.08	51.52	50.96	50.40
0	16	61.50	60.87	60.25	59.62	59.00	58.37	57.75	57.12	56.50
5	20	68.66	67.97	67.27	66.58	65.88	65.19	64.49	63.80	63.10
10	24	75.88	75.12	74 35	73.59	72.82	72.06	71.29	70.53	69.76
15	28	85.15	84.30	83.44	82.59	81.73	80.88	80.02	79.17	78.31
20	33	95.50	94.54	93.59	92.63	91.68	90.72	89.97	88.81	87 86
25	39	106.21	105 15	104.09	103.03	101.97	100.91	99.85	98.79	97 73
30	45	115 69	114 54	123.39	112.24	111.09	109.94	108 79	107.64	106 49
35	51									

mately as the absolute pressure, it follows that the refrigerating capacity of a compressor varies with the absolute suction (or back) pressure; thus, a compressor working under a suction pressure of 30 lb. (gage pressure) will have approximately 50 per cent greater capacity than one working under 15 lb. gage pressure.

To determine the refrigerating effect produced by the evaporation of 1 lb. of liquid ammonia at a given back pressure, a deduction must be made from the latent heat of evaporation at that pressure for the work required to cool the ammonia itself from the temperature at which it enters the evaporating coils to the temperature at which the evaporation takes place.

The temperature at which the ammonia enters the evaporating coils should be approximately that of the water used for condensing purposes.

TABLE II. NUMBER OF CUBIC FEET OF GAS THAT MUST BE PUMPED A MINUTE AT DIFFERENT CONDENSER AND SUCTION PRESSURES TO PRODUCE 1 TON OF REFRIGERATION IN 24 HR.

Temperature of Gas in Degrees F.	Corresponding Suction Pressure Pounds per Square Inch	Temperature of the Gas in Degrees F								
		65°	70°	75°	80°	85°	90°	95°	100°	105°
		Corresponding Condenser Pressure (gauge), Pounds Per Square Inch.								
		103	115	127	139	153	168	184	200	218
	G. Pres.									
—27	1	7.22	7 3	7 37	7 46	7.54	7 62	7 70	7 79	7.88
—20	4	5.84	5 9	5.96	6 03	6.09	6 16	6 23	6 30	6 43
—15	6	5 35	5 4	5.46	5.52	5.58	5 64	5 70	5.77	5.83
—10	9	4 66	4.73	4.76	4.81	4.86	4.91	4 97	5 05	5.08
—5	13	4.09	4.12	4.17	4.21	4 25	4.30	4.35	4 40	4.44
0	16	3.59	3.63	3.66	3 70	3.74	3.78	3.83	3 87	3 91
5	20	3.20	3.24	3.27	3.30	3.34	3.38	3 41	3 45	3 49
10	24	2 87	2.9	2.93	2.96	2.99	3.02	3 06	3 09	3.12
15	28	2 59	2.61	2.65	2.68	2 71	2 73	2 76	2 80	2.82
20	33	2.31	2.34	2.36	2 38	2.41	2 44	2 46	2 49	2.51
25	39	2.06	2 08	2.10	2 12	2 15	2.17	2 20	2 22	2.24
30	45	1.85	1 87	1 89	1 91	1.93	1 95	1 97	2 00	2.01
35	51	1 70	1 72	1.74	1 76	1.77	1 79	1 81	1 83	1.85

The accompanying table shows the number of cubic feet of gas that must be pumped per minute at different suction and condensing pressures to produce 1 ton of refrigeration per 24 hr. The values given are theoretical, and it is assumed that the temperature of the ammonia entering the evaporating coils corresponds to the temperature of condensation at the pressures given, and no allowance is made for unavoidable losses.

To obtain the net refrigerating effect of a compressor, it is, therefore, necessary to determine:

1. The suction (or back) pressure.

2. The temperature at which the ammonia enters the refrigerating coils.

3. The percentage of allowance to cover unavoidable losses.

In the operation of a plant it has been found that the following conditions represent a fairly average practice:

Back or suction pressure 15.67 lb. above atmosphere (at which pressure ammonia evaporates at zero), condensing water at 60 degrees F., which gives ammonia liquid a temperature of about 65 deg. F.; under these conditions it requires the handling of about 7500 cu. in. of gas per minute to produce the effect equal to melting 1 ton of ice per 24 hr.—Ice.

PERILS OF THE RUN

THE close calls that whiten the engineer's hair are mostly due to someone else's error or oversight which he cannot foresee or prevent. That many of these close calls do not result fatally is due to the engineer's swift and skilful meeting of the emergency.

Occasionally one of their drive-rod fastenings will break, and then every revolution of the wheel to which the other end is attached will send the rod swinging like a Titan's flail, beating down 300 strokes a minute.

Nothing can withstand these awful blows. They tear up the track below and shatter the engine above, especially the cab where rides the engineer. No disaster comes so unexpectedly and is so much dreaded as this. Almost invariably it happens when the engine is running at high speed. When a driver breaks it is a miracle if the men in the cab escape with their lives.

Only the other day one of the driving-rods of a fast passenger locomotive broke while the train was running more than 60 miles an hour down the steep grades of Pickerel Mountain. In an instant the whirling bar of steel had smashed the cab and broken the controlling mechanism, so that it was impossible to bring the train to a stop by ordinary means. The great locomotive lunged forward like a runaway horse that had thrown its rider. In some way, however, Lutz, the engineer, had escaped injury. He crept to the opposite side of the cab and climbed out through the little window upon the boiler to try to reach some of the controlling apparatus from the outside. He was working himself astride along the scorching boiler when suddenly the engine struck a curve, which it took at terrific speed. The shock half threw the engineer from his perilous position, but he saved himself by grasping the bell-rope. Then he worked himself down along the uninjured side of the swaying locomotive to where he could open one of the principal steam-valves. A cloud of vapor rushed forth with a tremendous roar. Although robbed of its power, the locomotive did not slacken speed until it reached the bottom of the grade. Then little by little the threshing of the great driving-rod, which was pounding the upper part of the engine to pieces, grew slower, and finally it stopped. No one was killed or injured, and not a passenger in the long train knew until it was over of the danger that had been avoided so narrowly.—Thaddeus S. Dayton, in Harper's Weekly.

CENTRAL BOILER PLANT OF THE BIGELOW CARPET CO.

REQUIREMENTS OF PLANT AND TEST RESULTS

UNTIL recently the Bigelow Carpet Co., at Clinton, Mass., operated 2 separate mills, one known as the Spinning Mill where wool scouring, spinning and preparation of the yarn is done, and located on the Worcester & Nashua Division of the Boston & Maine Railroad; the other mill, known as the Axminster Weaving Mill, where the dyeing and hacking of the yarns and weaving of rugs and carpets is accomplished, was ⅛ mile distant. Each mill contained its independent power plants, while all current for lighting was furnished from the weaving mill.

After careful investigation by its engineer, Chas. T. Main, of Boston, the company decided that a material economy of operation could be secured by concentrating its power generating units into one plant. Mr. Main was consequently instructed to proceed with the design and erection of a new power plant. A further consideration concerning the erection of a central power plant was the anticipated extension of the weaving mill.

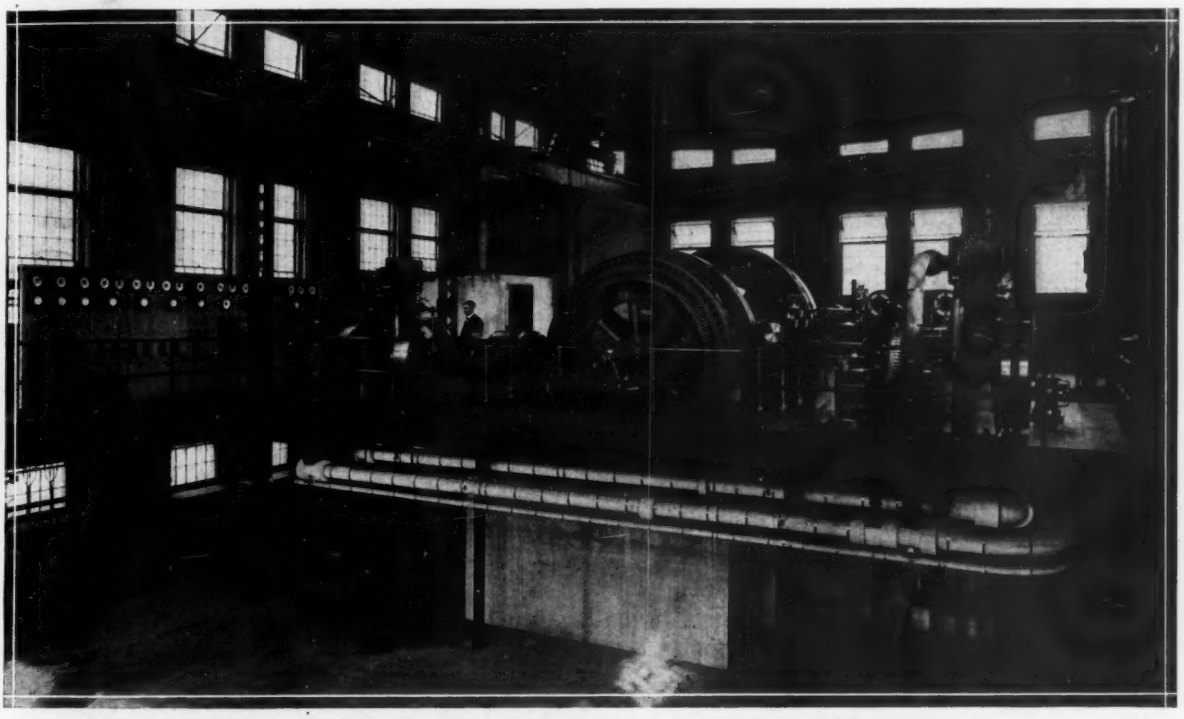


FIG. 1. GENERATING UNITS IN THE POWER PLANT OF THE BIGELOW CARPET CO.

Coal Pocket

THE new plant is located in a lot about half way between the 2 mills above mentioned, where advantage was taken of the slope of the ground for the arrangement of the coal pocket. A spur track from the railroad was laid on the top of the embankment, and a trestle extended from the end of it. The railroad tracks enter the coal pocket 18 ft. above the level of the floor, coal being dumped from the railroad cars to the bunker floor, thence loaded by hand into industrial cars and run through doors in the 20-in. fire wall which separates the coal pocket from the boiler room firing floor.

Each opening is equipped with a vertical rolling steel door and in front of each opening is a pair of 2-ton industrial scales with the registering device enclosed in a dust-proof case. The coal pocket is built of reinforced concrete with structural steel columns, brick walls and steel trusses to support the roof. Its dimensions are 71 by 197 ft., giving a total capacity of about 5000 tons and it is divided in the middle by a reinforced concrete fire wall to the height of the tracks.

Chimney and Buildings

CHIMNEY for the entire power plant, located in the coal pocket on the side next to the boiler room, is built of red brick, has a 10 ft. diameter flue, and rises 200 ft. above the boiler room floor. The boiler house, which adjoins the coal pocket, is 50 ft. wide by 197 ft. long, with a clear height of 23 ft. 6 in. to the bottom of the trusses.

For the boilers which face the coal pocket, there is a firing floor between the boiler front and the dividing wall of 20 ft. in the clear. All the firing is done direct from the industrial cars, no coal being upon the boiler room floor. All the coal is accurately weighed on being brought from the coal pockets.

The buildings are of red brick with granite trimmings, steel trusses to support the roofs which are of wood, covered with tar and gravel; floors are of vitrified brick embedded in concrete.

Boilers

BOILER equipment consists of 8 old boilers, which were removed from the Axminster Mill Power Plant, and 6 new boilers, with available space for 2 additional boilers to be installed later. The boilers

are of the horizontal, return tubular type, 84 in. in diameter with 180 3-in. tubes 19 ft. long.

There are 2 steam pressures in the plant—a high pressure system of 125 lb. gage, to provide steam for the main engines and auxiliaries and to the dye house, and a low pressure system of from 5 to 10 lb. gage, supplying steam to the feed-water heaters and the heating system of one mill. There is also a vacuum system in which the vacuum is kept at the proper point to maintain the desired temperature of the overflow water going to the dye house. All the boilers were built by the D. M. Dillon Boiler Works, Fitchburg, Mass.

Pump Room

THE pump room equipment consists of 2 International Steam Pump Co.'s fire pumps of 1500 and 1000 gal. capacity; of 3 14 by 8 by 12-in. duplex outside packed boiler feed pumps for regular service, and one 8 by 5 by 12-in. duplex vertical piston pump for night and Sunday service, manufactured by the Warren Steam Pump Co., of Warren, Mass., also an 8 by 7 by 12-in. duplex piston service pump for supplying cold water to the plant.

Boiler feed and fire pumps are equipped with Locke Regulator Co.'s pump governor and the service pump with a Fulton tank governor. The 3000-hp. Kelley-Berryman feed-water heater is also located in the pump room. The boilers are provided with Williams feed-water regulators, a necessary appliance in this plant, owing to the irregular demand for steam in the dye house. All the hot water supplied to the boilers is measured by Hersey water meters, one meter being installed for each battery of boilers.

As the supply of water is limited, its economical use for condensing and manufacturing purposes was very carefully considered by Mr. Main in the design of the plant. The suction of the boiler feed pumps is connected to the overflow line from the condenser, the water herein being heated to about 95 deg. F. This line also connects with the dye house, and has an overflow through an elevated loop, through which any excess water is discharged to the pond from which it was drawn to the condenser.

A test was recently conducted on boilers Nos. 7 and 8 by F. M. Gunby, of Mr. Main's staff of engineers, a description of which follows:

Boiler Test

THIS test was made at the new plant of the company on 2 84-in. Dillon horizontal return tubular boilers with Dillon shaking grates, Lamprey mouth pieces and dry pipes in the boilers. It was made on ordinary mill load to determine the evaporation of the boilers. The furnaces were brick having grates 6 ft. 7 in. wide by 7 ft. 1 in. deep, 2 to each boiler, giving 93.4 sq. ft. of grate surface. Boilers were set with shell 30 in. above the grates and had water heating surface of 5482 sq. ft., giving a ratio of water heating to grate surface of 58.7.

New River coal was used, the alternate method of stopping and starting the test being adopted. The weather was clear and warm and the test lasted from 7:10 in the morning to 5:30 in the afternoon, 10 hr.

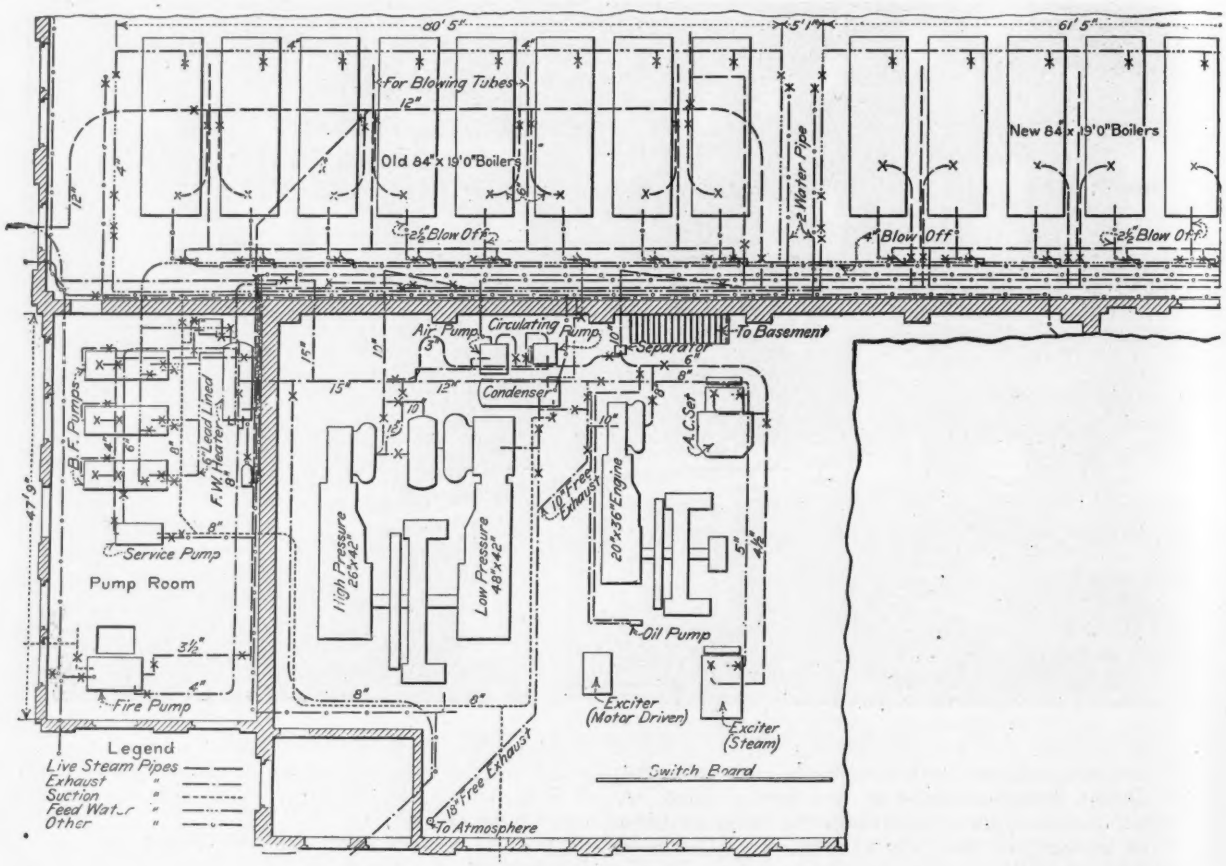


FIG. 2. PLAN OF THE BIGELOW CARPET CO.'S PLANT

20 min. The weight of coal fired was 23,404 lb. having 1.28 per cent moisture, leaving as dry coal 23,104 lb. The ash and refuse in the dry coal was 6.85 per cent and the calorific value 14,829 B.t.u. per pound. The coal gave as an analysis as fired, 1.28 per cent moisture, 20.47 per cent volatile, 72.79 per cent fixed carbon, 5.46 per cent ash. Based on dry coal this became 20.74 per cent volatile, 73.73 per cent fixed carbon, 5.53 per cent ash. The sulphur was 0.83 per cent of the coal as fed.

Water fed into the boilers was 217,360 lb., and corrected for the moisture of the steam, which was 2.66 per cent, gave 211,580 lb. evaporated. The factor of evaporation was 1.1657, the temperature of the feed

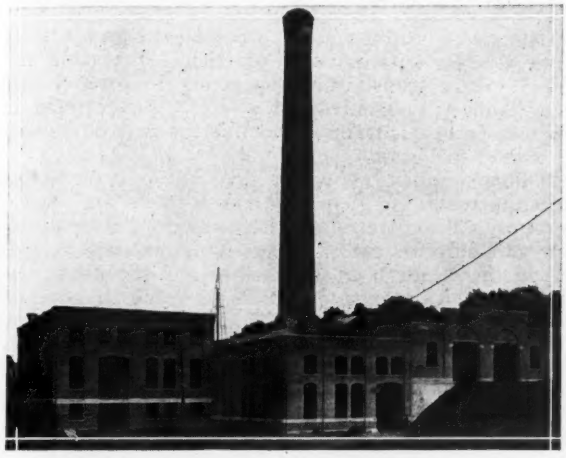


FIG. 3. POWER PLANT OF BIGELOW CARPET CO

water being 93.2 deg. F. and the steam pressure 109.1 lb. gage. This gives the equivalent water evaporated from and at 212 deg. 246,638 lb.

Reducing these to hourly quantities; dry coal per hour was 2235 lb.; dry coal per sq. ft. of grate per hour was 23.9 lb.; water actually evaporated per hour, 20,470 lb.; equivalent evaporation from and at 212

FIG. 4. BATTERY OF BOILERS IN CENTRAL PLANT

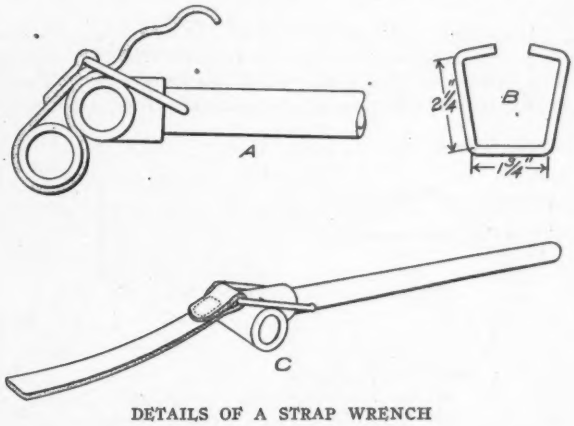
deg., 23,860 lb.; equivalent evaporation per hour per square foot of heating surface, 4.35 lb.; gases escaping at the average temperature of 388 deg. F. and the force of draft to the main flue was 8¼ in. Working out, results show that the boiler developed 715 hp. while the builders' rating at 10 sq. ft. of heating surface per horsepower was 548.2, giving the developed horsepower 130 per cent of the builders' rating. The water actually evaporated per pound of coal as fired was 9.28 lb., while the equivalent evaporation from and at 212 deg. per pound of dry coal was 10.68 lb.

Working out the efficiency of the boiler and grate based on dry coal as fired, gives 69.5 per cent. No Orsat apparatus was used but continuous readings from a $C O_2$ recording machine gave from 6 to 15 per cent, averaging 12 per cent for the test. The ash showed on analysis 39.63 per cent combustible and 60.37 per cent noncombustible material.

A STRAP WRENCH FOR NICKEL-PLATED OR BRASS PIPE

THE lever of this wrench is made from a piece of ½-in. gas pipe and a ½-in. tee. The tee must be smooth, without the beads. Thread the pipe on one end and turn it tightly into the middle opening of the tee. Drill a 5/16-in. hole in the pipe about ¾ in. back of the tee. The pipe and tee will appear as shown at A.

Take a piece of ¼-in. round iron or a bolt 8 in. long and bend it as shown at B. Spring the link thus



DETAILS OF A STRAP WRENCH

formed into the holes drilled in the pipe and press it together in a vise, or hammer so that the ends will meet in the center. A strap is fastened to the link as shown at C. Rub the strap well with powdered resin to insure a good grip on the pipe.—F. G. Lee in Popular Mechanics.

LIVE COALS FROM WILLIAMS MAGAZINE

IN business building, advertising is a substitute for time.

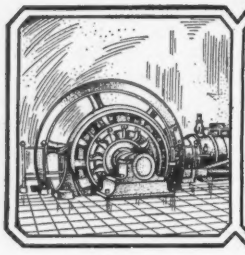
An aristocrat is one who is clean,—clean in body, mind and spirit.

Nature intended that men should help each other rather than fight each other.

Anger is a human boiler explosion,—it is not only a waste of energy, but it destroys the container of the energy.

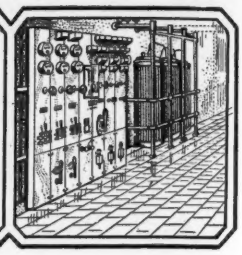
We are not suffering so much from the high cost of living as we are from the high cost of waste.

Be good natured until about ten in the morning and the rest of the day will take care of itself.



Electrical Machinery

For Generating, Transmitting and Using Current



RATINGS FOR SINGLE-PHASE TRANSFORMERS

FOR GROUPING ON POLYPHASE CIRCUITS

WHILE the rating of single-phase transformers is quite generally understood the capacity of such transformers when used in groups on 3-phase circuits is not always what it would appear to be. The cause of this apparent variation in capacity and the several groupings possible with single-phase transformers on 3-phase circuits are discussed here with the idea of giving the engineer a simple definite rule to follow in connecting transformers.

It is customary at the present time to rate single-phase transformers in kilovolt-amperes (kv. a.) rather than kilowatts (kw.), the term formerly used. The 3 quantities, which determine the rating of transformers,

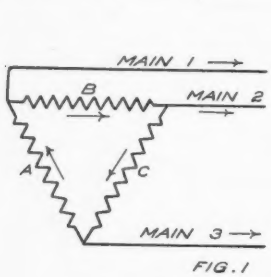


FIG. 1

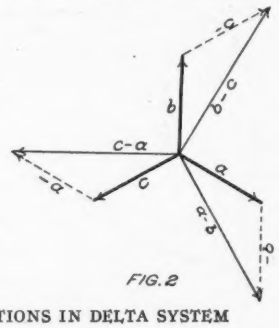


FIG. 2

FIG. 1. CURRENT RELATIONS IN DELTA SYSTEM
FIG. 2. RELATANT CURRENTS IN DELTA SYSTEM

are the current, voltage and frequency. The increase in current or voltage above the rating will increase the output, other conditions remaining the same, but losses will also be increased, causing the transformer to heat beyond normal temperature.

When 100 per cent power factor is secured on the line the rating in kilowatts and kilovolt-amperes is the same but with a power factor less than one, the capacity in kilowatts delivered, is decreased, as the necessary increase in the current required to keep up the power causes greater loss and more heating than is permissible. For this reason the manufacturer substituted kv.a. rating for the kw. rating, thus giving no chance for misunderstanding.

It is advisable, in some cases, to use transformers whose combined kv.a. capacity when used in parallel on single-phase circuits is greater than the kv.a. capacity desired of a 3-phase group. This is the case where the current is above the normal rating, due to the arrangement of the group. In all such cases where an increase of this kind occurs, the increase is 15.5 per cent, which will be demonstrated in detail later.

With transformers used on 2-phase circuits, there is no chance for error as the transformers can only be connected so that the rating of each transformer comprising the group is equal to one half the group rating. The 2-phase system being practically the same as 2 single-phase transformers operating in parallel on a single-phase system, except where 2 transformers are connected in quadrature, which is the case on 2-phase, 3-wire distribution.

This simplicity, however, does not exist on 3-phase circuits where single-phase transformers are used in groups. The current in each transformer is the resultant of 2 currents out of phase. This resultant depends upon the strength of the current and the phase relation, and in order to ascertain its value the simplest method is by the solution of a parallelogram of forces. In order to illustrate this we will take the case of 3 transformers connected in delta on a 3-phase, 3-wire, balanced circuit of the usual type where the currents in the lines are 120 deg. apart in phase.

Considering the current in main 1, Fig. 1, we will see that its value will be the resultant of the currents in A and B. Assuming that the positive direction of the current in the transformers is as indicated by the arrows, a positive current in transformer A produces a positive current in main 1, while a negative current in transformer B produces a positive current in main 1. Therefore the current in main 1 is equal to a—b, where a is the current in transformer A and b is the current in transformer B. Similarly the currents in mains 2 and 3 are found to be b—c and c—a respectively.

To find what this resultant, or vector sum is, refer to diagram Fig. 2. Here we have represented, by the 3 lines a, b, c, the phase relation and strength of the currents in the 3 transformers. We draw the line —b from the end of a, parallel and equal in length to b, then draw the line a—b from the common intersection to the end of —b, since the lines a and —b are of equal length and their included angle is 120 deg. the length of the line a—b is a times the square root of 3, or 1.73 a; it is evident that in a balanced circuit the current in any of the 3 mains is equal to the current in any transformer multiplied by 1.73. The voltage across the line is the same as that between the terminals of the transformer.

When transformers are connected in Y, by a similar course of reasoning, it is found that the current in any main is the same as in the transformer to which it is attached, but the voltage between mains is 1.73 times the voltage between terminals of any one transformer.

In the following analyses of the various groupings of single-phase transformers on 3-phase circuits, which are taken from an article by H. C. Soule in the Electric Journal, it is necessary to bear in mind that every single-phase transformer has a voltage and current rating which will be designated as E and I respectively, and also that the power of a 3-phase balanced

circuit is equal to 1.73 times the voltage between mains times the current in a single main times the power factor, which in the following cases is considered as one.

From the foregoing, it is fundamental that with 3 transformers delta connected, line voltage and current will be E and 1.73×I respectively, while the kv.a. rating of the group is equal to 1.73×E×1.73×I= 3EI. These values of the voltage, current and kv.a., that is, line voltage = E, line current = 1.73×I, and kv.a. of the group = 3EI, will, for convenience, be

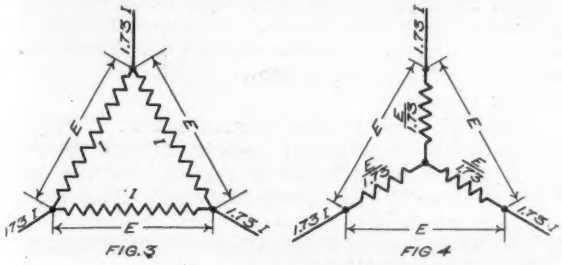


FIG. 3. DELTA CONNECTION
FIG 4. TRANSFORMERS CONNECTED Y

assumed for all cases discussed, and a one-to-one ratio of transformation is assumed. One winding only is indicated in the figures as the other is the same except for the case of 3-phase, 2-phase transformation.

Three Transformers Delta Connected

EACH transformer in this case has a rating equal to 1/3 that of the group rating, that is, the kv.a. rating of each transformer is equal to 3EI ÷ 3 = EI, since the transformer voltage equals the line voltage, E, the transformer current equals the line current divided by

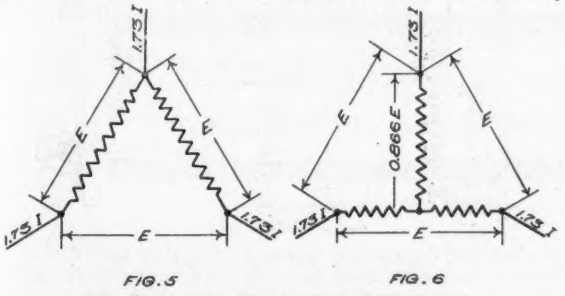


FIG. 5. OPEN DELTA OF V CONNECTION
FIG. 6. THREE-PHASE T CONNECTION

1.73 = I, the resultant kv.a. developed with both the primary and secondary windings is therefore E I.

Three Transformers Star Connected

THIS case also requires transformers with a rated capacity equal to 1/3 that of the group rating. As in the above case, the kv.a. rating of each transformer is equal to 3 E I ÷ 3 = E I, since the transformer voltage equals the line voltage divided by 1.73 = E ÷ 1.73, and the transformer current equals the line current = 1.73 × I, the resultant kv.a. developed in both primary and secondary windings is $\frac{E}{1.73} \times 1.73 \times I =$ E I.

In the case of 3 transformers connected in delta on one side and in Y on the other the values for the delta connected windings are the same as given in the first case, while the values of the Y connected windings are the same as the latter case, therefore the kv.a. rating of each transformer is E I.

Two Transformers V Connected

THIS is the connection which exists when one transformer of a delta group has been removed, as is indicated by Fig. 5, and is frequently called the open delta connection. The rating of each transformer in this group is 58 per cent of the group rating, that is to say, each transformer has a rating of 58 per cent of the power delivered by the transformer. Here the natural assumption that each transformer should have a kv.a. rating equal to half the total power output is not correct; since the transformer voltage equals the line voltage E and the current in each transformer equals 1.73 I, the resultant kv.a. developed in both primary and secondary windings is therefore E ×

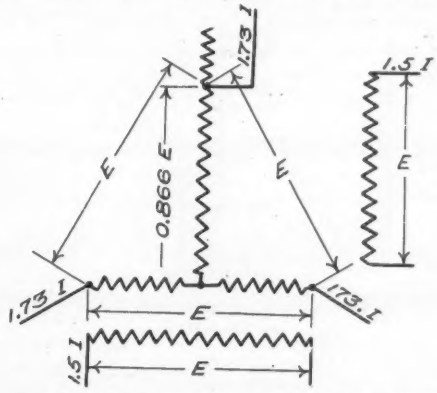


FIG. 7. THREE-PHASE, TWO-PHASE TRANSFORMER CONNECTIONS

1.73 I = 1.73 E I, which is 15.5 per cent in excess of ½ the total power output of the 2 transformers or 58 per cent of the group rating.

Two Transformers T Connected

TO analyze this it will be necessary to consider each transformer of the group separately. The transformer whose voltage equals the line voltage is called the main transformer, while the one whose voltage equals 86.6 per cent of the line voltage is called the teaser transformer. In the main transformer, it is evident that the voltage equals E, the transformer current 1.73 × I and the resultant kv.a. developed in both the primary and secondary windings is E × 1.73 × I. As in the last case it will be noted that this is 15.5 per cent more than half the group rating or 58 per cent of the group rating.

In the teaser transformer the voltage between terminals equals 86.6 per cent of the line voltage, equals 0.866 × E, the transformer current equals the line current, equals 1.73 × I and the resultant kv.a. developed in both primary and secondary windings is 0.866 × E × 1.73 × I = 1.5 × E I. The natural assumption that the rating of the transformer should equal ½ the group rating in this case is correct, but in ordinary practice transformers used for this group are of special design and it is customary to use duplicate transformers with a tap from the windings to give the required 86.6 per cent of the voltage of the entire windings. Each transformer, therefore, should have the same kv.a. rating, which is approximately 58 per cent of the group rating.

Three-Phase to Two-Phase Transformation

ANALYSIS of the T connection for 3-phase to 2-phase transformation is a repetition of the one just described for the primary winding; that is, the transformers should have a rating of 58 per cent of the

group rating with the tap taken off on the teaser transformer to give a voltage equal to 86.6 per cent that of the entire transformer. The secondaries, however, deliver to 2 entirely separate circuits and the rating of the coil would be ½ the total power output of the circuit or 1.5 E I. The natural assumption is true in this case also, and it is customary to design transformers for this system of connection with extra capacity in the primary or 3-phase winding only. This rating

TABLE SHOWING REQUIRED RATINGS OF SINGLE-PHASE TRANSFORMERS ON 3-PHASE CIRCUITS

Connections Employed. Primary and Secondary.	Number of Transformers in Group	Values for Each Transformer of Group.			
		Winding.	Voltage.	Current.	K. v. a.
Delta to Delta	3	Primary / Secondary	E	$\frac{1.73\,I}{1.73}$	$\frac{W}{3}$
Star to Star	3	Primary / Secondary	$\frac{E}{1.73}$	1.73I	$\frac{W}{3}$
Delta to Star	3	Primary	E	$\frac{1.73\,I}{1.73}$	$\frac{W}{3}$
		Secondary	$\frac{E}{1.73}$	1.73 I	$\frac{W}{3}$
V to V or Open Delta	2	Primary / Secondary	E	1.73 I	$\frac{W}{2}$ X 1.155
T to T	2	"Main" Primary and Secondary	E	1.73 I	$\frac{W}{2}$ X 1.155
		"Teaser" Primary and Secondary	0.866E	1.73 I	$\frac{W}{2}$
Three-Phase to Two-Phase	2	"Main" Primary	E	1.73 I	$\frac{W}{2}$ X 1.155
		"Main" Secondary	E	$\frac{1.73\,I}{1.155}$	$\frac{W}{2}$
		"Teaser" Primary	0.866E	1.73 I	$\frac{W}{2}$
		"Teaser" Secondary	E	$\frac{1.73\,I}{1.155}$	$\frac{W}{2}$

holds good for both 2-phase, 4-wire and 2-phase, 3-wire distribution, in either case the 2-phase voltages bear a 90-degree relation to each other and the primary or 3-phase voltage relations are not affected.

The accompanying table shows in condensed form what has been brought out in the analyses of the various methods of grouping single-phase transformers on polyphase circuits. In this table E is the voltage between mains, 1.73 I is the current in each main and W is the kv.a. rating of the group.

REVERSE CURRENT RELAY

By M. C. Saeger

WHEN 2 or more substations, or a storage battery are tied in on 1 system of bus bars, it becomes necessary to protect the individual generating units from a reverse current. This reversal of current may cause a great deal of trouble, such as the generators becoming motorized which would cause an excess load on the system. A storage battery tied in the system would suffer a heavy discharge in excess of the maximum rate, this high rate of discharge coming on when the battery may be working at a nearly discharged condition would render the battery useless to handle part of the system current.

The accompanying illustration will serve to enlighten the reader as to the modern method of installing and operating the reverse current relay.

In the diagram A is the first part of the relay to act in response to a reverse current, this instrument is constructed on the same lines as a millivoltmeter, with the exception that there are no scale graduations, the needle being used merely to make the contact at B.

Panels H and I are the testing apparatus and are used to test the operating condition of the relays, which is otherwise impossible without removing the generator shunt J. Panel I has mounted on it the controlling apparatus of the testing feeders from each generator unit; these feeders are taken from the stud at the positive end of the shunt. The indicator on the front of this panel shows which unit is in the testing circuit.

Panel H is a variable resistance used to vary the amount of testing current passing through the shunt J. R shows the direction of the load current and S the direction of the reverse current. Pilot lamp F is placed on the local battery circuit to show that the

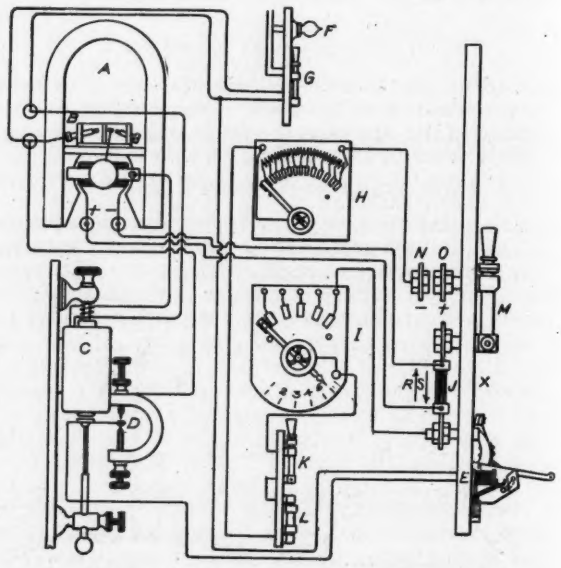


DIAGRAM FOR REVERSE CURRENT RELAY

potential of the local battery is always present. Switch G is used to disconnect the relays from the local battery in case of emergency.

In testing the relays a generator is selected which is not running and disconnected from the system. The rotary switch on panel I is then set to the generator selected for the test, the arm on panel H is then moved to the desired position, the current then has a clear path to the bottom of switch M, this switch being in the position shown. Generator switch is then closed in on the system bus. Current will then be flowing through the shunt in the direction indicated by S. The drop caused by the resistance of the shunt will furnish current enough to operate relay A, which closes contacts at B feeding the local battery to the telegraph relay coils C which in turn lift contact D closing the local battery to the circuit breaker trip magnet at E.

When opening up a boiler in which kerosene has been used, never use lights in or near it until the interior has been thoroughly aired out.

CIRCLES AND SQUARES

USE OF THE DOUBLE SCALE FOR BOILER PROBLEMS

TAKING up first the Problems for Practice from last month, the gallons of water in a cylindrical tank 6 ft. diameter by 9 ft. long are found by multiplying the area of one end of the tank by the length and thus getting the volume, and then multiplying this by the number of gallons in a cubic foot. Right here comes in one of the special conveniences of the Richardson rule.

Area of a Circle

TO find the area of a circle, we multiply the square of the diameter by 0.7854. By examination it will be seen that the values of the scale B are the squares of those on scale C, so that to find the square of a number, all that is needed is to set the runner to that number on C and read the square on B. We would then set 1 on B to 7854 and above the square which we had found find the answer on A.

FIG. 1. USE OF G TO FIND AREAS OF CIRCLES

Problem 3 to get the cylinder ratio for a compound engine with cylinders 12 and 20 in. diameter and 24 in. stroke, the ratio is found by dividing the volume of the low pressure by that of the high pressure. The

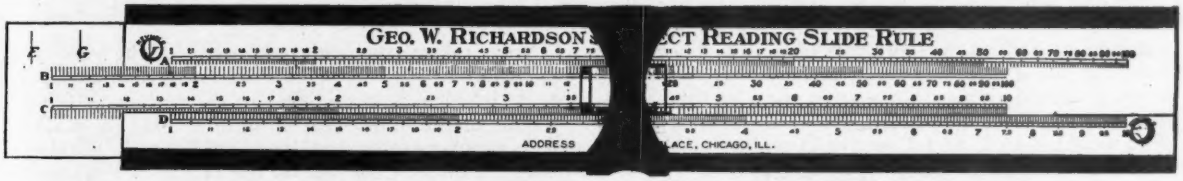


FIG. 2. USE OF J TO CHANGE CUBIC FEET TO GALLONS OR VICE-VERSA

If the key letter G be set to the upper keyhole, it will be found that 1 on B is at 7854 on A so that, if the runner is then brought to the diameter on C, the area will be found above the runner index mark on A. volume as in problem 1 is found by multiplying the square of the diameter by 0.7854 and by the length of the stroke, which brings 0.7854 and 24 into the volume of both high and low pressure cylinders.

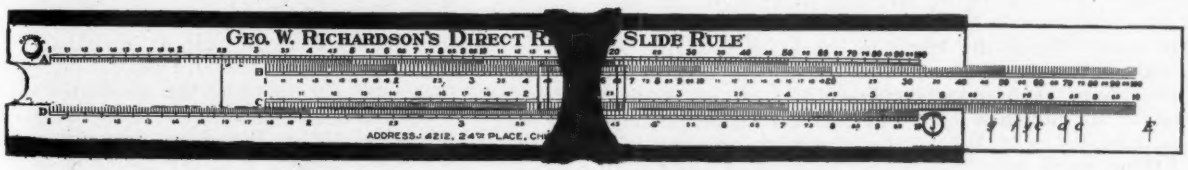


FIG. 3. USE OF j TO FIND CIRCUMFERENCE OF CIRCLES

As shown in Fig. 1 this gives for 6 ft. an area of 28.2 sq. ft.

Cubic Feet to Gallons

NEXT bring 100 on B to the runner, which is at 282 on A, and carry the runner to 9, showing 25.3 cu. ft. This is to be changed into gallons, and by looking on the back of the rule it will be found that the key J is to be used. Setting to J in the upper keyhole, Fig. 2 and with the runner at the cubic feet on C we find the gallons on D or 1895. Note that each of the divisions between 25 and 26 on scale C is 0.2 of the distance. This must always be watched, as the marked divisions are made 0.1 or 0.2 as may be necessary for clearness.

Circumference of a Circle

FOR the second problem, to get the surface to be painted on a stack 54 in. diameter by 63 ft. high, we have to find the circumference of the stack and multiply by the height. Here comes in another key. Looking on the back, we find that for the setting j, the circumference of a circle is found on A opposite the diameter on B, hence set at j as in Fig. 3 and over 4.5 on B, the diameter of the stack expressed in feet, is found 14.2 the circumference. Bring 1 on B to this, and over 63 on B is found on A, 892 sq. ft., the answer.

Both these factors will, therefore, cancel out in the division, so that we find that the ratio of cylinder volumes will be the ratio of the squares of the diameters. In this case it will be 20 squared divided by 12 squared.

Use of Squares of Numbers

WE have seen that values on scale B are the squares of those on scale C, and as scale A is exactly like B and D like C, it follows that values on A are the squares of those on D, so that if we make a division or multiplication on the C and D scales, the slide rule

is at the same time performing a like operation of the squares on the A and B scales, and we can read the result on the A scale. Therefore set the runner to 20 on D and bring 12 on C to the runner, and over 1 on B will be found 2.78 on A the ratio of squares and therefore of cylinder volumes required. The settings are shown in Fig. 4.

For the fourth problem, we have to get the percentage clearance of the 2 cylinders above if it takes 1.2 gallons of oil to fill the high pressure, and 4.6 gallons to fill the low pressure clearance space. We must reduce the cylinder volume in each case to cubic inches and also the gallons to cubic inches so that we can get the per cents.

Gallons to Cubic Inches

TAKING first the high pressure, we get the area from the diameter by using the key G as in Fig. 1, and over 12 on C find 113 on A. This times 24, by bringing 1 on B to 113 on A and looking above 24 on B gives 2700 cu. in. on A. To change gallons to cubic inches, use the key S in the upper keyhole, and over the gallons on D find the cubic inches on C; over 1.2 is found 277.2, for we know that 1 gallon is 231 cu. in. Then dividing 277.2 by 2700, gives 0.1025 or 10.25 per cent as the clearance.

By the same process we get for the low pressure cylinder, area = 314 sq. in.; volume = 7200 cu. in.; clearance = 1062 cu. in.; and this is 14.78 per cent. In changing the gallons to cubic inches, it is necessary to set at S and then run the slide over so that the 1 takes the place of the 10 on the C scale in order to get a reading on C at 4.6 on the D scale.

FIG. 4. FINDING RATIOS OF SQUARES BY USING BOTH PAIRS OF SCALES

Rated Boiler Horsepower

TURNING now to some calculations in regard to boilers, one of the examination questions answered in this issue is as follows: Find the horsepower of a boiler 4 ft. in diameter and 15 ft. long, having 30 4-in. tubes, considering half the shell and none of the heads as heating surface, and using 12 sq. ft. to the horsepower. First, to figure the shell we have to multiply the circumference by the length and take half this product. Using the key j in the lower keyhole, we find above 4 on B 126 on A, and this is divided in the usual way by 2 and multiplied by 15, giving us 94.2 sq. ft. for the shell. For the tubes, 4 in. in diameter will be 1/3 of a foot; using, therefore, the key j as before, we have to find 1/3 on the scale B. We shall have to reduce this to a decimal and it is handy to note that it is 0.333, therefore we set the runner to that figure on B, then multiply by 15, that is, bring 1 to the runner and then carry the runner to 15 and multiply also by 30, the number of tubes, by bringing 1 to the runner and carrying the runner to 30, and we have 471 sq. ft. This added to 94 gives us 565 sq. ft. total. Dividing this by 12 gives us the horsepower, 47.

Boiler Horsepower From Evaporation

TAKING now the question of boiler horsepower from performance, suppose that a boiler uses 4150 lb. of feed water per hour, at a temperature of 198 deg., and evaporates this into steam which is 2 per cent moisture at 130 lb. gage pressure. What is the actual horsepower generated? We know, of course, that a boiler horsepower as established means the evaporation of 34.5 lb. of water per hour from and at 212 deg. into steam, and we must, therefore, find the equivalent evaporation of the boiler from and at 212 deg. The easiest way to do this is to find what is called the factor of evaporation, which is the number of pounds of steam that would be evaporated from feed water at 212 deg. into steam at 212 deg. by the heat that actually was put into a pound of steam.

Heat that comes into a pound of steam is the heat contained after the steam is evaporated minus the heat in the water when it came to the boiler. Looking in steam tables we find that for 130 lb. gage pressure the total heat in a pound of steam is 1189.9 B.t.u., and at 198 deg., the heat in a pound of water will be 198—32 or 166 B.t.u. Simply as a matter of fact it should be remembered that these figures do not represent all the heat in either steam or water, but they represent the heat above that in a pound of water at 32 deg., which is what we take as the starting point in all computations. The amount of heat added to a pound of steam by the boiler will then be 1189.9—166 or 1023.9, and the heat to evaporate a pound of water from and at 212 deg. is 966 B.t.u.

Now, taking the slide rule, we set the runner at 1023.9, and in this case 1024 is about as near as we can get it; bring 966 on the slide to the runner and below the end of the slide scale C we find 1063 on scale D, the computation having been made with the lower scales. This is 1.063 and is the factor of evaporation for the actual boiler conditions. Now we wish to know the steam actually evaporated and as 2 per cent of the steam was moisture, 98 per cent was turned into steam and we multiply 4150, the feed water used, by 0.98 in the usual way and get 4060 lb. of steam evaporated. Multiplying this by the factor of evaporation 1.063 gives us the equivalent evaporation from and at 212 deg., or 4320 lb. per hour.

Looking on the back of the rule we find that the key P gives us the relation between evaporation from and at 212 in pounds per hour and the standard boiler horsepower, therefore, setting P in the upper keyhole we set the runner at 432 on B and opposite this on A we find 125 the horsepower that the boiler is delivering.

Strength of Boiler Shell

ONE further problem on the safe strength to be carried by a boiler. Suppose that a boiler is made of 3/8-in. plate, is 48 in. in diameter with a double riveted lap joint in the longitudinal seam and the steel has a tensile strength of 60,000 lb. to the square inch, factor of safety to be 5. What is the safe pressure to be carried? The rule for this is as follows: Safe pressure equals 2 times the tensile strength of the plate, times the thickness of the plate, times the efficiency of the joint, divided by the factor of safety and by the diameter of the boiler, all dimensions to be in

inches. The average efficiency of a double riveted lap joint may be taken at 75 per cent or 0.75, and then writing the operations down in one expression we have, for the case in hand,

$$\frac{2 \times 60{,}000 \times \frac{3}{8} \times 0.75}{5 \times 48}$$

This becomes now simply a case of continued multiplication and division. We will use the upper scales because it brings the numbers in the same position on the rule that they are in the expression as written. First, bring the runner to 2 on A, then bring 5 on B to the runner; carry the runner to 6 on B and bring 48 on B to the runner; carry the runner to 3 on B and bring 8 on B to the runner; carry the runner to 75 on B and above this on A we read 1415. By the regular process of inspection or by good judgment, since we know about what that strength of plate and size of boiler would carry, this is 141.5 pounds.

Horsepower of Chimney

IN figuring volumes we find how to figure with the squares of numbers on the upper scales; by reversing we can work with the figures on the upper scale and find below them the square roots on the lower scales. A problem where this comes in is in the calculation of the size of a chimney. Suppose that we wish to know the size of chimney to take care of 500 hp. of boilers, the chimney to be 120 ft. high. Kent gives, assuming that a boiler burns 5 lb. of coal per horsepower-hour, the following expression: The effective area of a chimney is equal to 0.3 the horsepower of the boilers divided by the square root of the height of the chimney in feet. From this effective area we can find the effective diameter and the actual diameter is found by assuming that there will be a 2-in. layer of dead air or gas all around the outside of the chimney so that we add 4 in. to the diameter found from the effective area.

Use of Square Roots

TAKING the figures as given, we have then,

$$\frac{0.3 \times 500}{\sqrt{120}}$$

We start working on the lower scales and set the runner to 3 on scale D. We want to divide this by $\sqrt{120}$. If we point this off into places of 2 figures, as in finding the square root, we find that it becomes 1'20; therefore, we must use the left-hand end of the scale. If it were 12'00 we should use the 12 on the right-hand part of scale B. If we now bring 120 on B to the runner the figure below C will be $\sqrt{120}$ and we shall be dividing 3 on the D scale by the $\sqrt{120}$ on the C scale. The quotient would be found under 1 on the C scale, but as we have to multiply this by 500 we go on with the computation by bringing 10 on the C scale to the runner, then carrying the runner to 5 on the C scale and underneath this we find 13.68 as the square feet effective area for the chimney.

Diameter of Circle From Area

NOW to find the diameter of the effective area we use again key G and setting the runner to the area on A, 13.68, we find on scale C the diameter 4.17 feet. Multiplying this by 12 to get it to inches, we have 50 in., and adding 4 in. to give the actual diameter gives us 54 inches as the diameter of the chimney. In multiplying 4.17 by 12 it is simpler to transfer 4.17 onto the D scale before making the multiplication, since this keeps our operation in the usual order.

Problems for Practice

FIND the horsepower of a boiler 60 in. in diameter and 16 ft. long, having 44 4-in. tubes at 12 sq. ft. of heating surface per horsepower. Use 2/3 the shell and the back head minus the tube ends.

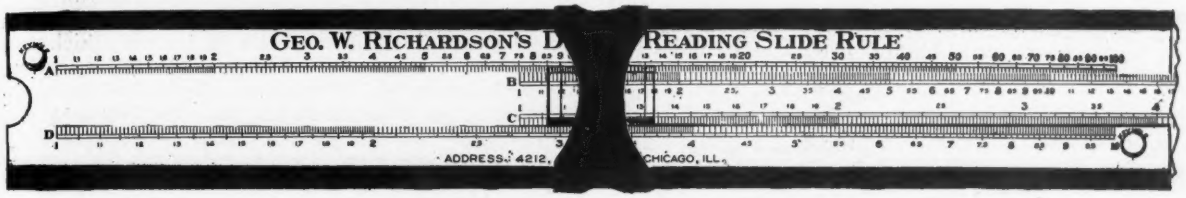


FIG. 5. DIVIDING 3 BY THE SQUARE ROOT OF 120

2. Find the horsepower developed by this boiler if it evaporates 12,200 lb. of water in 5 hours, the feed water having a temperature of 196 deg., the boiler pressure being 130 lb. gage; what is the percentage of the rated horsepower?

3. What size of square up-take flue will have the same area as a round chimney 52 inches in diameter?

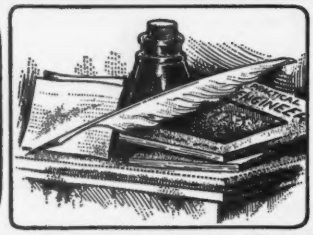
NOVEL FUEL SUPPLY

THIS sounds like a made-up item concocted by some reporter in an off hour when his imagination ran away with his sense, but it is really no worse than other things which have appeared in newspapers from time to time. The source in this case is the Herald, of Syracuse, N. Y., and the item is given by The Locomotive in a recent issue.

"For the last month the sawmill here has been running on a fuel which puzzled the fireman of the boiler, and not until Friday did he solve the enigma.

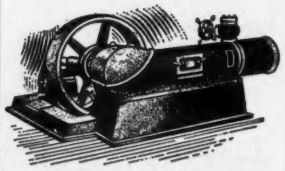
"Several weeks ago the fireman was feeding the firebox a cord of 4-ft. wood a day; while today he uses only a few sticks in the morning to start the fire. The boiler is fed from a creek back of the mill, a 3-in. pipe running from the boiler to the stream. This creek is noted for its small eels. The eels ran up the pipe to the injector on the boiler and were forced into the flues [!]. The hot water soon cooked the eels, and investigation showed that the boiler contains several barrels of eel oil. The flues of the boiler leak,—not badly, but just enough to let the oil into the firebox, where it keeps up a seething flame."

As a method for getting fish chowder and operating a boiler at the same time, this has certain advantages, also it contains a suggestion for those who believe in the use of kerosene as a boiler compound. Let it work as a compound first and then leak through into the firebox and serve to keep the boiler running.



Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



FEED PUMP TROUBLE

SEEING what H. C. M. says of a pump in the August issue reminds me of the trouble I once had under like conditions. It was a new boiler and I had gone inside before it was connected up and found everything all right to my own satisfaction, but after the boiler was accepted, it carried water over whenever forced.

One day we were shut down for some purpose and after the water went down a little I started the feed pump. The fire was banked and when I went back to the engine room I heard some hammering. I went to investigate but before I got to the feed pump the valve between the check and the boiler burst, and as

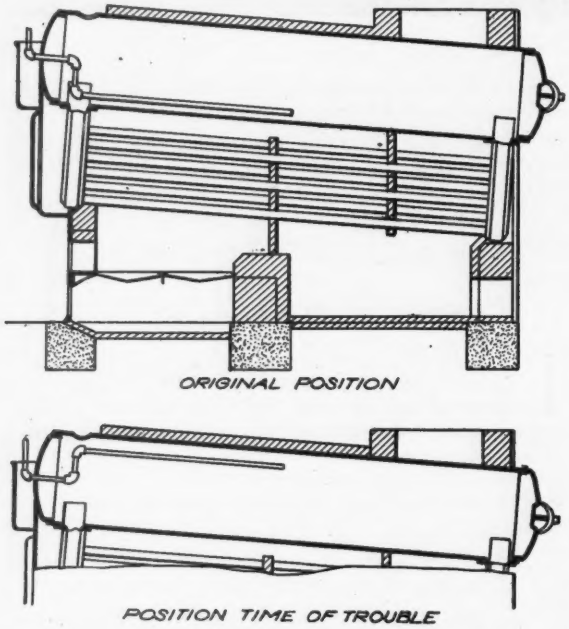


FIG. 1. POSITIONS OF FEED PIPE IN BOILER

the valve stem faced out, it blew out disk and all. It was a cheap valve and I suppose was the weakest point.

There was 75 lb. of steam on. We pulled the fire and after the boiler cooled down I went inside, as I thought the feed pipe must be too high; I found the steam fitter or his helper in connecting on to the feed pipe on the outside had given it a half turn on the inside, feeding the water into the live steam space.

I returned the pipe to its original position, but there was still a hammer and the water carried over. The feed water is 208 deg. F., so I fixed it this way; I ran the pipe straight down and put a tee on it, so that it discharged in what I figured was the coolest part, and we have had no trouble since. F. T.

PITTING OF BRASS PIPES

THIS may seem to some engineers to have been caused by the ghost of Halley's Comet, but whatever the cause it happened with the surface blowoff pipe outside of the extension front of the boiler and discovered after the pipe was removed to add a stop valve. The inside of the pipe was examined for scale and corrosion, and was clear, except for some oblong, gray spots of incrustation about 1-64 in. thick and which varied in area from 1-64 in. wide by 1-8 in. long to ¼ in. wide by ½ in. long. Some of the spots showed no incrustation at all. No attention was paid to the spots until the pipe had been cut and threaded. Then a hole was discovered, apparently a flaw on the inside of the pipe, tapering smaller as it passed through the thread. The piece being spoiled a new pipe was put in, and a nipple cut off the old pipe to connect a union. The repair was completed, the joint being

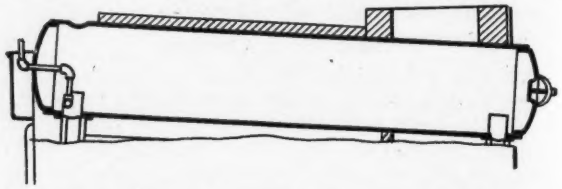


FIG. 2. REVISED ARRANGEMENT OF FEED PIPE

made with Smooth-On cement on account of a bad dye thread making a ragged thread on the pipe.

The next day there was a pin hole leak at the edge of the union. Thinking this was in the thread I endeavored to calk in some more cement. The Smooth-On should have stopped the leak had it been in the thread, but instead it only made it worse and a new nipple was put in. This pipe was very hard, apparently having become brittle from 15 years' service. Examination showed that 2 of these spots were cone shaped, ⅛ in. by ¼ in. and pieces 3-16 in. by 5-16 in. had popped inward leaving very small holes on the outside of the pipe.

These spots when scraped off would show clear brass, flush with the surface, with a slightly dark mark around the outside edge and they could not be scraped out, but when pressure was applied, by screwing the pipe hard into the fitting or by hammer or driving the calking tool, they popped out on the inside like scale, the hole appearing like an old fracture.

The water used in the boilers was from the city main and a rain-water tank in the yard. There was also a tank on the roof to supply water to the building. This tank was supplied from a well 400 ft. deep and occasionally overflowed, the water passing over the roof down into the rain-water tank, thence to the boilers. It had long been known that the well water would eat out the iron pipes at the ends and form scale in the boilers, which, although fairly hard was easily removed with salsoda. I have seen many pipes eaten

in holes from acid and badly corroded with boiler scale. But this case of a surface blowoff pipe, the water passing through it having come out of the boilers, is somewhat mystifying. The rain-water tank having been cleaned out the day before this discovery was made, it was impossible to get a sample of the water for analysis. I should like to hear from some of the readers of Practical Engineer on this subject.

R. A. Cultra.

STEAM PIPING FOR KILNS

IN the September issue I notice with interest the question of steam heating by B. C. A., the data on the subject is somewhat indefinite and to go into details as regards condensation of pipe, etc., would take up too much space, we will have to look at the matter in a somewhat condensed form. The 3 dry kilns are quoted as being 30 by 90 in., this evidently is an error and most assuredly means 30 by 90 ft.

His engine is a 300-hp. slide valve and most certainly not any more economical than the usual run of slide valve engines. Steam pressure is not given so there is nothing to base the theoretical terminal pressure upon, but the probabilities are that the cutoff is around ¾ stroke, thus making a pretty high terminal pressure which would certainly appeal to the feasibility of using the exhaust for the kiln. There are, however, several conditions to be dealt with and on which I can only make some suggestions as he himself, knowing the exact conditions, must decide the question.

First, the present pipe 3 in. in diameter would not be large enough, as he has 3 kilns fed by a 3-in. pipe at boiler pressure, I would suggest making this pipe 8 in. or the full size of the exhaust from the engine, thereby giving a good, full supply of steam clear to the kilns, being very particular to see that this steam passage is not choked anywhere or the area of the pipe reduced. The area of the different pipes that lead to the kilns must collectively be as much as the main pipe also the headers in the kilns and outlet. If the combined area is a little more it will be still better as it will reduce the back pressure on the engine and there will most assuredly be some back pressure if only from pipe friction alone for it is a long length of pipe.

Another question; is the engine loaded to its full capacity? If so back pressure would be a serious problem as each pound of back pressure would add to the load and require just so much more on the other side of the piston. It is not to be presumed that he could raise the boiler pressure to meet this condition as according to his article he must be carrying all he is allowed. Of course he would need a good back-pressure valve in the exhaust that leads to the atmosphere as he could then adjust the pressure on the kilns to what would be necessary, also a shut-off valve on the main pipe to the kilns. If these conditions are correctly assumed, I am convinced the exhaust will do the work.

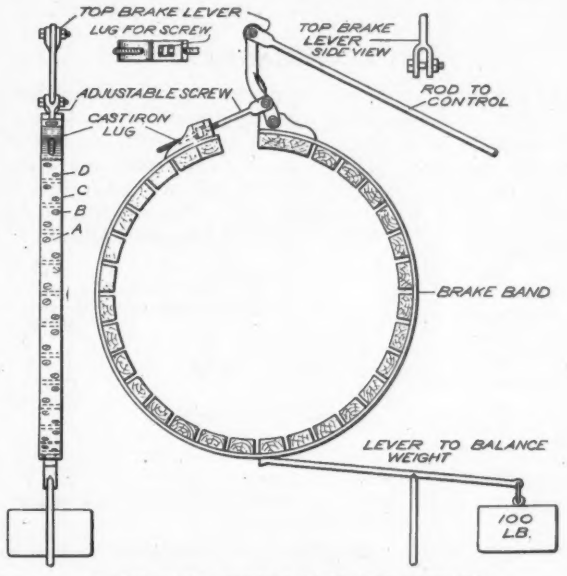
Regarding the steam proposition at night and the amount of fuel used, much depends on the quality and kind of wood used, 7 cords of wood seems like a big lot of fuel to use and I don't wonder that B. C. has to break in new firemen quite frequently. I myself once had a similar experience with sawdust and shavings and can sympathize with him. One cord of hickory wood is equal in British thermal units to 2000 lb. of coal, while 1 cord of white pine is only equal to about 30 per cent of this amount, and so consequently there is a wide variation in the quality of fuel.

Another question to be considered is whether the live steam is properly trapped, that is, are the drips taken care of or simply run to waste? It would be surprising to a good many engineers if they realized how much steam can be wasted by simply dribbling the drip through a common valve. If such is B. C.'s condition it would seem that a good return trap or sump and receiver to put this return drip back into the boiler would be a good investment, as it is already heated and would require less cold water for the boilers and less fuel and consequently less work. Also, is the pipe well covered to reduce the amount of pipe condensation? A good and cheap suggestion by W. F. Cox is worthy of the consideration of B. C. These, however, are only suggestions the feasibility of which B. C. must be the judge.

C. H. T.

BRAKE BAND CONSTRUCTION

HEREWITH is a rough sketch of a brake band which I am using, the study of which may possibly help A. R. out of his brake-band troubles. The band is lined with wood blocks, as shown in illustration, being fastened to the band with screws A, B, C, D, etc. These blocks should be made of some hard, tough wood, preferably dogwood or the like, which have been placed in oil and let stand until they are thoroughly soaked, then taken out and placed on the band, as shown. These, with the aid of the balance weight shown, will stop all jumping of the brake.



BRAKE BAND WHICH DOES NOT VIBRATE

Wm. A. Hayworth.

REFRIGERATION ON SHIPBOARD

TO A. Mellien, whose article appeared in the September issue, I would say that your warrant machinist is right, but perhaps he did not explain to you enough, so you could understand why your ice machine gives better result when the air is cooler at the start. But if you would try to reason it out, you would find the answer very easily.

No doubt that you know on what basis the machine is making ice, but you have got the wrong idea of the heating of air in the compressor. Of course during compression, the air becomes hotter than it was when entering the compressor. Suppose the atmospheric

air, when entering the compressor, was 90 deg. F. and when compressed to 240 lb. becomes heated to 160 deg., which is an increase of 70 deg., but, when the air enters the compressor at a lower temperature, say 40 deg., and under compression the heat increased 70 deg., it will be only 110 deg. The air coming back from the system is cooler than the atmospheric air, and when the air is compressed over again to 240 lb. it does not increase the temperature to 160 deg. This is the reason that you can produce more refrigeration with cooler air at the start.

But to make my assertion stronger, I will state another case. On a cold day (I don't mean in winter time but when atmospheric air is cooler and the circulating water is of the same temperature as on a warm day) by observation you will notice that you are getting better results. Then again perhaps you run the port machine faster, if so, the cold air travels faster and naturally gives you better results.

Perhaps the starboard machine has more friction, which of course would increase the heat, and consequently you would not get as good results.

But how can you prove that you are getting better results, as one machine runs on the refrigerator and the other on the ice box and scuttle butt?

M. Strzyczkowski.

VALVE HANDLE

MANY engineers have been annoyed by broken handles on valves fitted with the wood wheel type of handle. In such cases I use a solid wheel cut out of rubber belting. This makes a fine handle for water gage fittings, it is very simple, but will save lots of trouble and is worth passing on. The illustration explains itself. The holes are cut with a belt punch.

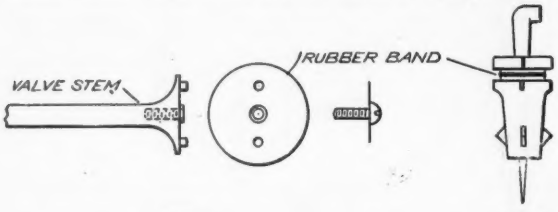


FIG. 1 FIG. 2

FIG. 1. PARTS OF VALVE HANDLE MADE FROM RUBBER BELTING

FIG. 2. TOOL FOR REMOVING TUBES

Figure 2 is a rough sketch of a tool that I used with good results to remove old tubes from a boiler. It is made like an ordinary spring expander with the exception that it has a sharp cutting ring instead of the usual raised ring for spreading an internal bead. The tool is made in 4 sections and the pin has a projection on the side for ease in removing from the flue. I have never seen another tool like this, and so far as I know the idea is original. Chas. Fenwick.

WAVY LINE EXPLAINED

IN reply to the request on Page 435 of a late issue of Practical Engineer I will say that in the opinion of the writer the wavy expansion lines are caused by the vibrations of the pencil motion. They are an indication that the indicator piston is in good condition and working freely, as they can generally be distinguished from the series of steps or notches sometimes found on the expansion line caused by the sticking of the indicator piston, as they are not so angular in appearance. The cards seem to indicate fairly good steam distribution. If my calculations are correct—I have no planimeter—the horsepower is approximately 78.

On Page 437 H. C. P. submits a set of cards for criticism. The cutoff seems to be too early in the low-pressure cylinder as the steam expands below the back-pressure line as indicated by the loop. This would, of course, cause the high back pressure shown on the high-pressure card. The compression is rather early also, in the writer's estimation. The drop in the steam line such as is shown on the cards is the result of a high rotative speed and is quite common with shaft-governor engines especially, as the valve opening is often restricted and steam cannot follow the piston fast enough to keep the pressure up to that at the beginning of the stroke. In fact the events in both cylinders show poor steam distribution.

Le Roy Scott.

EXPERIENCE WITH PACKINGS

IN a recent issue of Practical Engineer is a good article from W. E. Sanders, on What Packing Shall I Use, and while I think his suggestions practical I would like to state my experiences on boiler feed pumps with outside packed plungers. I have used a cushion packing and found that when renewed, it would run some 3 weeks continually night and day with temperature of the feed water 200 deg. F. If the pump was used for a closed heater and pumping cold water, it would last as long again.

In inside packed pumps the regular duck and rubber square packing would work nicely pumping cold water. I prefer to have an expansion ring with light tension inside of the packing. Some engineers prefer to have the follower plate squeeze the packing, while I prefer to have the packing free of the follower.

On Corliss and slide-valve engine valve stems and piston rods, I have used wedge packing. This works very well, if the proper attention is used when tightening the glands.

In one of our Corliss engines here with the piston rod 4 in. in diameter, we used some makes of packing, which had to be renewed every 6 or 8 days. The mill was shut down for repairs some 7 mo. ago. The piston gland was removed, and metallic packing was made in the shops here; something similar to the U. S. multiconical shape. This packing has now been in use 7 mo. night and day excepting Sundays, and no repairs nor expenses have been made of any kind. C. W.

OHIO LICENSE LAW

THERE appeared in the September issue an article by Mr. Rounds in regard to the Ohio license laws, in which he stated that the third class men do not study to get a better license.

Why should they, when he says they are just as good as first-class licenses? About 85 per cent of all stationary engineers get less than $3 for 11 to 13 hr. work and have anywhere from $5,000 to $50,000 worth of property in charge, while hoisting engineers get $4 to $4.80 for 8 hr. work with about $2,000 worth of property in their care and do not need a license. Why study?

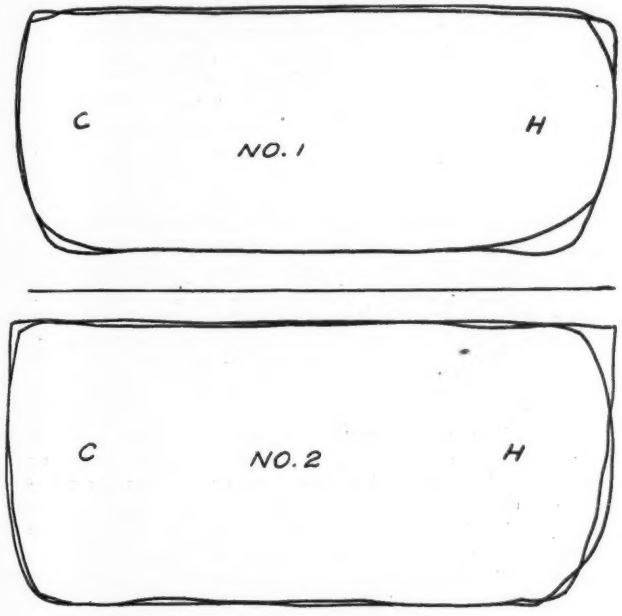
He gets $4 to $4.80 while the building is being put up according to the contract. When the building is all completed the employer gets an engineer with first-class papers and gives him $3.50 or $4 for 12 hr. of his time. The engineer with first-class license puts in 360 hr. while the unlicensed man works 240 hr. for the same amount of money. Why study? A. H. E.

COMMUTATOR REPAIR

AS to a filling to go between 2 segments of a commutator of a Westinghouse dynamo of 258 volts 90 amperes, the writer has had a similar trouble, and has remedied it to good advantage by filling the cavity with dentist's cement, which is used to fill teeth. Mix the cement with water and apply it as quickly as possible, for it dries very quickly. J. S. Perry.

ESTIMATE OF CURRENT DESIRED

THESE cards were taken from the high-pressure side of a Cooper Corliss cross-compound engine 22 by 44 by 42, rated by the builders at 1350 hp. with 145 lb. steam and 24-in. vacuum, cutoff at ¼ stroke, engine running 94 r. p. m., scale of spring 60 lb.



CARDS FROM AN OVERLOADED ENGINE

The railway load on these engines varies so much that at times they carry all hooks for 3 to 8 minutes. Electrical output at these times is unknown for the reason that our ammeter registers only 1500 amperes on 410 volts.

Will some one give us an estimate of what the engines are doing under these conditions?

Will it be any disgrace to go down and out with 3 300-hp. Stirling boilers in the boiler room when one is cut out for cleaning?

You will understand that this is not a fixed load condition and no one knows when it is coming or how long it will last. H. Johnston.

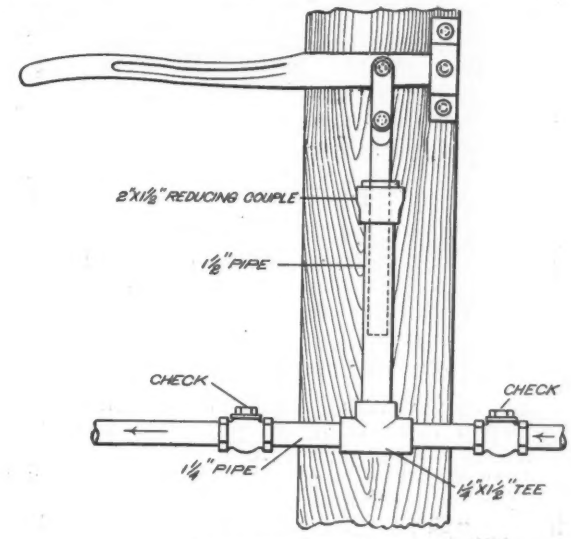
INTERLOCKING BOOSTER CIRCUIT BREAKER

IN my opinion a consideration of the booster connections outlined in a recent issue of Practical Engineer will show that it would be poor practice to wire the booster motor to the bus bars solid as suggested in that article. There are many circumstances under which a motor wired in that manner could be totally destroyed.

In modern installations using motor driven boosters, the motor and booster circuit breakers are interlocked both mechanically and electrically. In case the motor breaker opens for any reason the lever which connects the motor breaker to the booster breaker acts on the trip of the booster breaker and opens it also. The electrical interlock consists of a speed limiting device on the booster shaft which operates trip coils attached to both breakers and opens them. The installation of either one or both will effectually prevent any damage to motor or booster. P. J.

HAND FORCE PUMP

OUR correspondent, Wm. S. Luckenbach, has called attention to the fact that in the cut shown in the October issue of a hydrostatic force pump, Page 629, it would be better if the pump were arranged so that the down stroke of the handle produced the down stroke



HAND FORCE PUMP

of the plunger, as shown in the illustration herewith, since more force can be exerted when pushing downward than when pulling upward.

FLOW OF WATER

ON page 634 of the October issue of Practical Engineer, H. M. S. gives a problem which I believe neither he nor the mechanical engineer has given due study. My idea is that practically an equal amount of water will come from either way and offer the following solution for my reasons.

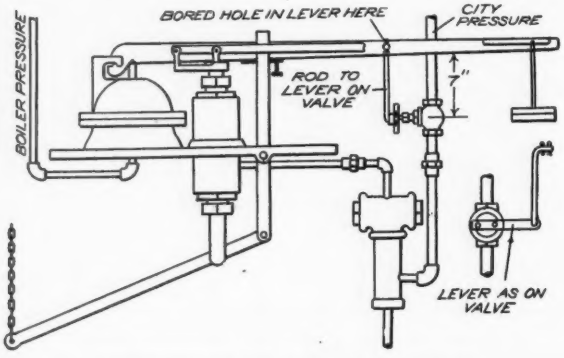
It is known that a column of water any diameter and 1 ft. high exerts at its base a pressure of 0.434 lb. per square in., nearly. This being the case a column 80 ft. high will exert a pressure of 80×0.434 lb. or 34.72 lb. This then is the pressure at the bottom of the vertical pipe, or water main pressure at that point. In measuring his sketch I find the faucet to be 52 ft. above the water main and the level of water in tank to be 28 ft. above the level of faucet. Now, a column of water 52 ft. high will exert a pressure of 52×0.434, or 22.568 lb. It is seen that this pressure is bucking the pressure in water main and will reduce the pressure at the faucet this amount, leaving 34.72—22.568, or 12.152 lb. This then is the pressure at faucet due to the pressure in

water main. Now the pressure at the faucet due to the height of tank will be 28×0.434, or 12.152 lb., or the same as that due to the water main pressure. This proves than an equal amount of water should come from either direction. Using this method for determining the problem, or others like it, I will add that the faucet could be located anywhere along the pipe and the results would be the same.

Paul E. Capraro.

SAVING WATER ON DAMPER REGULATOR

I HAVE a Carmichael damper regulator made like the Spencer, taking water on both the opening and closing of damper. It is operated by water from the city main at 60 lb. pressure. When I first went to work on this plant, I noticed that the water ran in a continuous stream from the discharge pipe of the damper regulator. I came to the conclusion that it



ARRANGEMENT OF DAMPER REGULATOR

was using too much water, so I looked it over and found that it was set all right, but needed a new valve, as the old one was quite worn.

Having gotten a new valve and piston center, as you have to get both in this kind of regulator, I put them in, and set the valve. I then found that I lost more water than I ought, even after this change. I came to the conclusion that the city water pressure was a little higher than was necessary to work the regulator. I measured a quantity of the water so I could tell whether I had made any improvement or not. At last I put this compensating device on it, and found that I could save about half the water used before.

The compensating device is illustrated herewith; the water pipe runs down the wall, back of large lever. I placed a valve just below the lever, about 7 in., having the valve stem pointing towards the damper regulator, then put a lever on the valve stem long enough to come out under the lever. A hole was bored in the end of this lever, also in the lever on the regulator in line with it, and the 2 connected together by means of a rod, the ends being bent to fit into the holes in the levers. Small holes are drilled in ends of this connecting rod for cotter pins to prevent the rod from coming out. The rod should be long enough so that when the damper regulator is open the valve will be shut.

When the damper is open the water is entirely shut off, which prevents leakage, when steam pressure rises, the lever opens the valve, gradually allowing only a little water to get to the piston and operate it, so if it should stay in this position a short time, the water being wire drawn would not be wasted as much as if the valve was wide open. As the damper opens, the water is wire drawn more and gradually shut off.

D. W. Etchings.

FLOW FROM AIR-TIGHT TANK

IN the October issue C. B. Hudson relates his experience with vacuum in a return tank, and, in a way, compares it with the air-tight tank and pump described in the July number.

To my mind the comparison is not applicable; for, in the first case, the tank is filled (presumably) with cold water, while in the second, it is partially filled with hot water.

Now, it is well known that hot water can not be pumped unless the supply is above the pump, for the vapor rising from the water destroys the vacuum in the cylinder.

In Mr. Hudson's case there was plenty of water in the tank, but the vacuum prevented the pump from getting its supply. Why?

The vapor arising from the hot water destroyed the vacuum in the suction end of the pump raising the pressure in the suction chamber to that of the atmosphere or near it. With more or less of a vacuum in the tank, the weight of the water alone, in the suction pipe was not sufficient to overcome the tension of the valve springs and the pressure from the atmosphere, consequently the pump could get no water. The opening of the cock at the bottom of the water glass, admitted air to the tank, broke the vacuum and the water flowed again to the pump.

Now, in the case mentioned in the July number the conditions are different. The tank is filled with cold water and is air tight. The pump is below the tank. When the pump makes a few strokes, there is a vacuum produced in the suction chamber, more or less complete, there being no vapor arising from the water, there is nothing to destroy the vacuum, the water will flow to the pump as long as there is any left in the tank. For, as the water leaves the tank, there will be a vacuous space above the water and it will flow from a vacuum to a vacuum.

A. K. Vradenburgh.

THAT FREAK (?) CARD

THOSE cards shown by W. D. on page 510 Aug. number, would indicate to me that when the last pair of cards were taken, the head-end hook slipped off and allowed the valve to close, almost as soon as it had opened, this belief is strengthened by the appearance of the crank-end card.

When the head-end hook slipped off the momentum of the flywheel carried the engine over, the speed slackened, the governor dropped, and when the crank end took steam the long cutoff followed as a matter of course.

I find that when these blocks begin to slip a little kerosene instead of engine oil has a tendency to make them hold. By using kerosene I have made the blocks hold another month before turning them over.

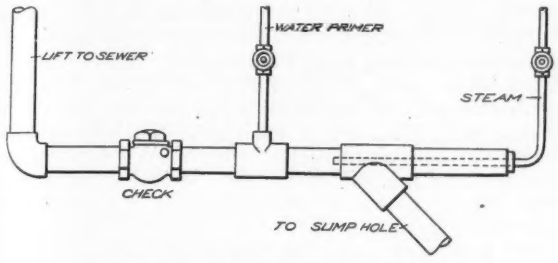
H. Skaton.

A STEAM EJECTOR

DURING a recent overhauling of the plant where I am employed, I ran across quite a little trouble regarding the position of the receiver and duplex pump for disposing of the return condensation from the heating system. The receiver was provided with 2 return pipes, one of which conducted the return from the upper part of the factory by

gravity and the other from the lower floor which was on a level with the receiver.

The dry pipes from the different radiators were necessarily carried down under the floor to return to the receiver, consequently a pocket was thus formed which filled up with drip and the system refused to work successfully. Various ideas were tried but as the top of the receiver was about 6 ft. above the level of the return pipe under the floor, it was impossible to push the water into the receiver with the same steam pressure that was used on the upper part of the factory. According to the usual law 1 lb. of steam



EJECTOR MADE OF PIPES AND FITTINGS

pressure is equivalent to a lift of 2 ft. of water. Consequently there was a deficiency of pressure in the lower line of 3 lb.

As a final experiment a cellar was dug and cemented under the engine room floor and the receiver was installed there, absolutely all drips being relieved by gravity. This was successful but as the floor level of this cellar was below the sewer we ran into trouble regarding sump, etc. A 1¼-in. Y fitting was obtained and bushed on the straightaway with a 1¼ by ⅜-in. bushing, a ⅜-in. pipe was screwed into this that had a continuous thread 15 in. long and extended inside the discharge pipe as shown. This ejector was placed horizontally and to it were attached an ell and short piece of pipe, which was perforated to prevent any refuse from being drawn up from the sump pit.

When we started the rig all that we could do was blow steam to the sewer. We then cut the pipe about 6 in. from the end of the inclosed ⅜-in. pipe and piped a ½-in. water pipe with a valve for control to act as a primer. This arrangement worked better but the discharge was very spasmodic and not at all satisfactory. A check was now inserted 6 in. from the primer pipe; we then obtained a steady discharge, the result being that the pipe above the check is continuously filled with water and the steam combined with the sump water acts on the principle of an injector in which the high velocity of the water forces open the check and causes an even pressure or load on the ejector.

SHRINKAGE OF WATER

ON p. 504, issue of August, T. C. R. explains the cause of that "Low water in the morning" question. His explanation appears very good if we do not check it up with our own actual experience. I admit that my experience has never proved his explanation to be true; perhaps because I have never operated boilers in his locality.

My experience has taught me that the expansion of water in a return tubular boiler will cause a variation of from 2 to 4 in. in the level of the water; we all know also that the larger body of water we have the more expansion we have.

Each cu. ft. of water expands a like amount under the same conditions but 500 cu. ft. will give 500 times that amount and 100 cu. ft. will give 100 times that amount, hence the greater quantity of water contained in a boiler the greater will be the variation of the water level, due to expansion. We are all well aware that (size for size) a water-tube boiler contains much less water than a return tubular, and how T. C. R. satisfies himself that contraction alone is the cause of the water going down out of sight every morning in his boilers, I can't see.

He says, figure it out; well here goes. We will take a return tubular boiler, and see how much expansion or contraction we find, assuming that the water in the morning is at 212 deg. F. and the working temperature is 350 deg. F., that corresponds to 135 lb. pressure per square inch absolute or 120 lb. gage. The boiler is 16 ft. long between the heads; 54 in. inside diameter, contains 60 tubes, 3¼ in. outside diameter. For the sake of simplicity we will neglect the space occupied by the braces, steam outlet pipe, etc.

The level of the surface of the water is 16 in. from the top of the boiler shell. Total area of head is

$$54^2 \times 0.7854 = 2290.23 \text{ sq. in.}$$

Area of segment exposed to steam is

$$\frac{4\,h^2}{3}\sqrt{\frac{D}{h}} - 0.608 \text{ where}$$

h is height of segment and D is diameter of boiler.

$$\frac{4 \times 16^2}{3}\sqrt{\frac{54}{16}} - 0.608 = 567.63 \text{ sq. in.}$$

Cubic contents of steam=63.07 cu. ft. Area of end of 60 tubes.

$$3.25^2 \times .7854 \times 60 = 497.75 \text{ sq. in.}$$

Area of head exposed to water

$$= 2290.23 - (497.75 + 567.63) = 1224.85 \text{ sq. in.}$$

Cubic contents water=$1224.85 \times 16 \times 12 = 235171.2$ cu. in.

$$\text{Cubic feet of water} = \frac{235171.2}{1728} = 136.09, \text{ say } 136 \text{ cu. ft.}$$

136 cu. ft. at 350 deg. F. weighs 55.52 lb., and the total weight is $55.52 \times 136 = 7750.72$ lb.

After cooling to 212 deg. F. one cu. ft. of water weighs 59.76 lb. Hence, $7750.72 \div 59.76 = 129.8$ cu. ft., thus the shrinkage=136—129.8=6.2 cu. ft.

When the water is 16 in. below the top of the shell the width of the surface of the water is about 50 in.; as the water lowers, this width increases, but this increase of width I will neglect for simplicity.

Area of the surface of the water=$50 \times 16 \times 12 = 72{,}000$ sq. in. The shrinkage in cubic inch is $1728 \times 6.2 = 10{,}713.6$ cu. in.; hence fall in inches due to shrinkage is, $10{,}713.6 \div 7200 = 1.48+$ or say 1.5 in.

WISCONSIN ENGINE CO., of Corliss, Wis., has recently received a contract for three horizontal cross-compound condensing engines for the Tide Water Portland Cement Co., Union Bridge, Md. Each engine will be 23 and 46 by 48 in. driving direct a 925 k.v.a. 3-phase 60-cycle alternator and will be furnished with special valve gear, cylinders and governors peculiar to the "higher speed" Corliss engines built by the Wisconsin Co. Close regulation and economical performance on variable load will be special features of the design.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Questions for Second-Class Massachusetts License

WHAT is the equalizer in a horizontal return tubular boiler and how does it work?

2. Which seam in a return tubular boiler gives out first, and why?

3. How would you find the safe working pressure on the flat surface of a boiler without tubes or stays in it?

4. If a safety valve was set to blow off at 100 lb. and did blow off at the right pressure but closed only after the pressure fell to 90 lb., how would you make it close at 98 lb.?

5. If the safety valve is set to blow at 100 lb. and you want it to blow at 60 lb., how will you change it?

6. Give 3 reasons why a duplex pump has 5 ports on the steam end.

7. What effect will increasing or decreasing the lost motion on a duplex pump have on the pump action?

8. How would you alter compression on one end of a Fitchburg engine, and how are the exhaust valves fastened to the rod?

9. If the weight on a Fitchburg governor flew off what would happen to the engine?

10. If the springs on a Fitchburg governor broke, what would happen to the engine?

Power Costs

WHAT will be the cost of installation of a 500-hp. steam plant, Corliss engine, boiler, heater, pumps, foundations, piping and small accessories? And what will be the cost for a producer and gas engine plant of the same capacity?

Also what will be the yearly cost of operation for each?

Flat Eccentric

WHAT causes my eccentric to wear flat? Has anyone had a similar experience? A. W.

Power for a Centrifugal Pump

I HAVE a No. 2 centrifugal pump with 3-in. suction and 2-in. discharge, to work under 40 ft. head and with 10 ft. of horizontal pipe having 2 elbows, 1 next the pump and 1 near the end of the discharge. There are no elbows in the suction pipe. I would like to hear from readers of Practical Engineer what size gasoline engine should be purchased to run this. Would a 5 hp. be sufficient? V. D.

Peculiar Bell Action

IN our engine room is a bell system composed of 2 single-stroke bells wound for 125 volts, operated with a compound wound dynamo, direct current, 15 kw., 6 poles and electromotive force 125 volts. The dynamo acts on the bells as if there is a short circuit on the line shortly after current flows. The bell armatures are strongly attracted by magnets, causing the hammers to hang up. This machine has been tried with long shunt, short shunt, and series windings, with rheostat on the series windings and also on the shunt and on the mains leading to the bells and has been run above and below speed. We have also a bipolar dynamo, direct current, series wound for 10 kw., 125 volts, and a bipolar Edison dynamo, 3 kw. electromotive force 125 volts, with which the bells work very well. Can anyone tell us where the trouble comes? W. T. T.

Belt Queries

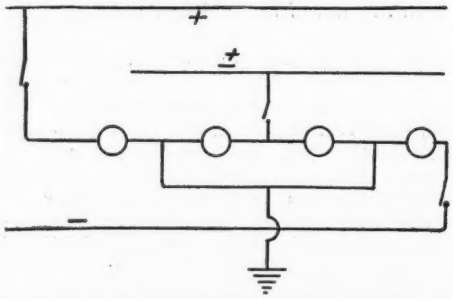
I WOULD like to have somebody tell me if a canvas belt is as good as a rubber belt in regard to power and lasting qualities. We need a new belt 12 in. wide and about 55 ft. long. There is a great deal of dust and moisture present.

2. Can anybody tell how to stop the short stroke in starting a pump, I have a single dean pump?

3. I would like to know if there is any better lacing for belts than lace leather; if so, where could I get it? H. C. G.

Wiring of Ground Detector

MY plant is electrically driven, voltage being 250, 2-wire circuits for both power and lights. Lately we put up a new building and installed a balancer set to operate the lights on the 3-wire system while



GROUND DETECTOR CONNECTIONS FOR 3-WIRE SYSTEM

motors operate at 250 volts, that is, lights in the new building only are on the 3-wire circuit while lights in the old buildings are still on the 2-wire. The question is how to wire up ground detector lamps on the 3-wire lighting circuit. I know the system is grounded but the ground lamps on the bus bars of the 2-wire do not show the ground. A. E. Carroll.

A. The action of a ground detector is exactly the same, whether you have a 2-wire or a 3-wire circuit. Of course, if your ground detector is connected only to the 2 outside wires, you cannot detect with this a ground on the neutral wire, and as you are certain

that your circuit is grounded, the probabilities are that the ground is somewhere on this third wire.

The connections of the ground detector should be exactly the same between each outside wire and the neutral as between the 2 outside wires, only using 110-volt lamps instead of 220-volt. The connections are as shown herewith.

Care of Idle Boilers

MY way of caring for idle boilers is to wash the boiler out and fill with clean water then clean the ash and soot from all external surfaces and let it stand with 2 or 3 gages of water until wanted again. Of course if the water contains a large amount of acid that will cause corrosion, this plan would not be advisable nor should such water be used to feed the boiler, but with ordinary boiler waters the possibility of having another boiler ready for use in case one of the boilers in service gives trouble should not be lost sight of and with ordinary feed water the boiler should be kept full and ready to fire up.

J. C. Hawkins.

Generator Connections

WE have a ground return circuit in which we are running 2 dynamos in parallel, compound winding. The switchboards are the General Electric and the dynamos are Ridgway, made by the Ridgway Dynamo & Engine Co. For ordinary compound wound

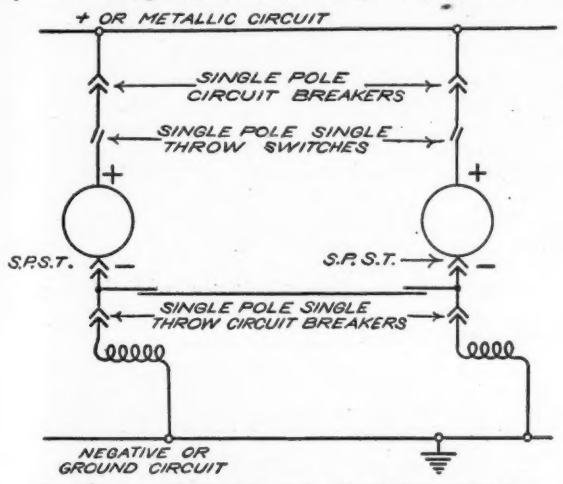


FIG. 1. CONNECTIONS FOR COMPOUND WOUND GENERATORS

machines the arrangement of Fig. 1 was suggested and seems to be satisfactory, but with the Ridgway machines there is trouble from flashing over with this connection and the circuit has been changed as in Fig. 2. This, however, leaves the positive panel practically out of commission. Can we connect this as in Fig. 3 and would it work all right? Why will other machines work with the connection, as shown in Fig. 1, while the Ridgway will not?

A. Replying to the second part of your question first, the compound winding in the Ridgway machine is a compensating winding instead of a compounding, that is, it is a winding arranged in series with the armature and wound so that it neutralizes the armature reaction on the field strength and at the same time provides a commutating field. Under these conditions if the circuit breaker on the negative side, Fig. 1, goes out, it leaves the armature of the machine still in operation but the compensating winding is not there and as this compensation winding is what provides the field for commutation the brushes will flash and spark when the negative breaker goes out.

Evidently from what you say there is a tendency for the circuit breaker on the ground circuit to go out before the one on the metallic circuit. If the positive circuit breaker be set to go out first it will

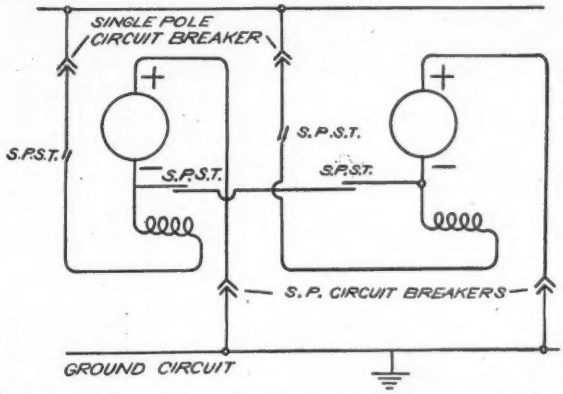


FIG. 2. PRESENT CONNECTIONS OF RIDGEWAY GENERATORS

prevent all difficulty with the machines, no matter how the dynomos are connected on the negative side.

The arrangement that you have shown in Fig. 3 will be all right but is somewhat complicated. If it is imperative that you should have the negative circuit breaker close last and open first, then the connections as shown in Fig. 3 will be all right or you could change the circuit breakers on the negative side so that they would be beyond the series coils, i. e., between series coils and the grounded circuit. In that case when the negative breaker opened it

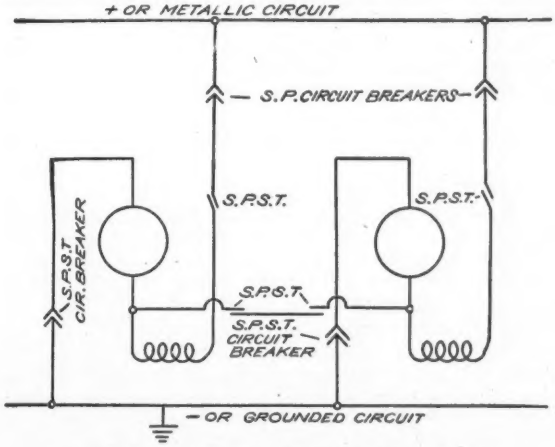


FIG. 3. PROPOSED CONNECTION FOR RIDGEWAY GENERATORS

would put the machine out of commission and would operate satisfactorily.

Quality of Oils

ENGINE oils for high speeds should show a viscosity of at least 170 and should range up to 195 at ordinary temperature of about 75 deg. The oil should show a specific gravity of about 30 and the flash test should be between 400 and 450 deg. F. In the case of slow speed engines the oil should have a viscosity

from 195 to 215 and a specific gravity of 24, with a flash test between 440 and 460 deg.

This article above was published some time ago. I do not understand the terms used in the above article. What is the meaning of specific gravity of 30, and flash test of 400, and the meaning of a viscosity of 195 at ordinary temperature of 75? Also what is the difference between fire test and flash test?

Duty of pumping engine=foot pounds of work÷total number heat units×1,000,000; under this rule our engine gives 95,000,000, what does this denote, good or bad, or how many million is the best and what is the poorest? John Vossler.

A. The term viscosity means the fluidity or freeness of flow, and the method of measuring this is rather confusing. The viscosity is usually taken as the number of seconds required for a given amount to flow through a given orifice, but the exact figures mean nothing unless you know the machine that is to be used for testing.

In regard to specific gravity, it is the weight as compared with the weight of water, but your figure of 30 would indicate that you have the gravity Baume, which is a French method of measurement in which water is taken as 10, and on this scale a medium engine oil has a gravity of 24, sperm oil a gravity of 29. The specific gravity of oil will always be less than that of water because oil is lighter than water, and the specific gravity of a medium engine oil will be 0.909 and of cylinder oil about the same. A light engine oil has a specific gravity of 0.892.

To change from specific gravity to gravity Baume, multiply the specific gravity by 130, subtract this result from 140 and divide by the specific gravity, or divide 140 by the specific gravity and subtract 130. The method of making this determination is by means of a hydrometer, which is an instrument having a bulb which floats in the oil or whatever liquid is being tested and sinks until a certain mark comes even with the surface.

As to the flash test, this is made by heating the oil in an open cup and passing a lighted splinter above the surface. A thermometer should be kept in the oil so as to take the temperature. The temperature at which the vapor above the oil takes fire is the flash point.

The fire test is made by continuing the heating of the oil above the flash temperature and noting the temperature at which the oil itself catches fire and continues to burn.

As to the duty of the pumping engine, this is usually defined as the foot pounds of work done per million B.t.u. consumed by the pump. The expression would in its original form be: Duty equals foot pounds of work, divided by (total number of heat units divided by 1,000,000). Your duty, as figured of 95,000,000 foot pounds, corresponds to about 18 lb. of steam per horsepower per hour and is very good performance. The poorest performance is that of boiler-feed pumps, which runs down to about 9,000,000, and the best is that of the big pumping engines, which runs up to 150,000,000.

Pressure Gage and Hydrometer

PLEASE explain the water gage in reference to gas pressure, also the hydrometer to gravity.—F. T. S.

A. The water gage is simply a U tube, usually made of glass, and the difference in level between the water in the 2 sides shows the pressure on the closed end. The gage is usually made as shown in Fig. 1, connected by means of a rubber tube and pet cock to the pipe or vessel in which the pressure is to be measured.

When there is no pressure on, the water will stand at the same level in both legs of the U. When the pressure comes on the water will drop in leg A and rise in leg B, and the difference in level will measure the amount of the pressure in leg A. This is usually given in inches of water, but can be transformed into pounds per square inch by the rule that 1 in. difference in level of water equals 0.036 lb. per square inch.

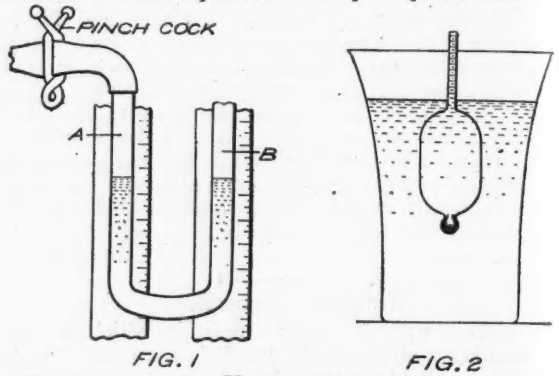


FIG. 1. U TUBE WATER GAGE
FIG. 2. HYDROMETER

The hydrometer is an apparatus weighted so that in pure water it will sink to a mark on the stem which is indexed as 1. The specific gravity of all liquids is referred to the density of water, and if a liquid has a specific gravity of 1.2 it means that it is 1.2 times as heavy as water.

The hydrometer is graduated by trial in liquids of known densities, that is, a cubic inch of water weighs 0.036 lb. and a cubic inch of alcohol weighs 0.029 lb., so that the specific gravity of alcohol is 0.792. On the other hand a cubic inch of mercury weighs 0.489 lb. and its specific gravity is 13.596. The hydrometer is simply graduated so that it will sink until the mark on the stem opposite the surface of the liquid shows the specific gravity of that liquid.

Direction of Water Flow

REFERRING to the problem on page 634 of the October issue of Practical Engineer, I submit the following: The water discharging from the cock when opened, will come from both above and below. The ratio between the rate of flow from the tank and the rate of flow from the main will be the inverse ratio of the square roots of the lengths of pipe through which the water flows. That is: If R= the rate of flow in gallons per minute from the tank; and r= the rate of flow in gallons per minute from the main; L= the length of pipe from cock to tank, and l= length of pipe from cock to main, then $R:r::\sqrt{l}:\sqrt{L}$.

Suppose L to be 60 ft. and l 15 ft. (these values were not stated in the problem) then:

$$\frac{R}{r} = \frac{\sqrt{60}}{\sqrt{15}} = \sqrt{\frac{60}{15}} = \sqrt{4} = 2 \text{ and } R = 2r$$

That is to say that twice as much water will come from the tank as from the main. This, it must be remembered, will be the condition when the cock is first opened. It is evident, however, that as the water level drops in the tank, a diminished quantity of water will come from above, while the flow from below will be increased.—J. M. Row.

ANSWERS TO EXAMINATION QUESTIONS

SEPTEMBER ISSUE P. 585

By William E. Dixon

FIRST make sure that the water really is so low that you can't find it. Though gage cocks show steam and there is no water in glass, still it may be within safe limits. Blow off water glass to make sure it is clear. Then shut top glass connection. If the glass fills you may safely pump up and go ahead.

But if water cannot be found, immediately open fire doors and cover fire heavily with wet ash or soil, or if neither is available use wet coal so as to kill the fire. Shut ash pit doors, leave fire doors and damper open. Do all this before touching engine or pump. Cooling off in this way will tend to lower the water level; and if the pump has been running without doing harm, it may continue to do so for some time, especially if engine is running. If both engine and pump are running, let them run until steam drops to 25 or 30 lb. Then shut both down. In the meantime, see if blow-off valve is closed, look in at both ends of boiler to see if there are any red hot tubes or any other signs of overheating anywhere. If pump or engine or both are not running, leave them alone. If feed pump takes water direct from city mains don't forget that when boiler pressure drops below city water pressure, water will run in unless a valve is shut.

If everything appears to be all right and pressure begins to drop when no steam is being taken from the boiler we may assume that there are no longer any overheated parts; and as soon as pressure is reduced to 20 or 25 lb. water may again be introduced into the boiler. Take care to heat this water as hot as possible—blowing steam through the engine into the heater if necessary. Note time taken to fill to bottom of gage glass and then to fill up to first gage cock. Calculate where water level had fallen to. If this was evidently above the tubes, no further action is necessary. If fusible plug has been uncovered and did not let go it should be replaced at once.

Probably it will be found that few if any tubes have been uncovered; and, if so, raise steam slowly and resume operation. Watch for leaky tubes and report case to boiler insurance company or state inspection department, if there is any such. If it is evident that many tubes and some plate were exposed, the boiler ought to be inspected and tested before resuming operations.

The above applies where there is only one boiler. If the boiler is one of a battery, smother the fire as in first case, and shut all ash pit doors reducing pressure in all boilers to lowest possible operating pressure. Then cut out the affected boiler and cool it down and treat it as in above case.

(A) As some answers given by other correspondents treat the problems in a different manner that seems worthy of record, we have given to some of the questions 2 or more answers. 1a is from O. B. Critchlow and 1b from H. G. Roberts.

1a. A question such as this one opens a wide field for conjecture and the display of judgment and many things in any particular plant would have to be taken into consideration to govern the engineer's action but in general I would say:

If the engine were in operation and the feed pumps or other boiler feeder was supplying water to the boiler I would leave these conditions unchanged, test the column and glass by blowing out to make sure they were not clogged, have a look at the fire sheet of the boiler and close the draft, bury the fire with damp coal or ash, close the fire doors and then attempt to locate the trouble.

The first thing I would be likely to inspect would be the blow-off valve, if this were found to be closed and not leaking I would next turn my attention to the feed pump and as the most likely place to locate the trouble. I would first inspect the discharge and suction valves as they would be more liable to sudden failure than would the packing of the water end.

I place the examination of the pump second in consideration for the reason that a sudden failure of the pump through the breaking of any of its parts would almost always attract immediate attention while failure for want of packing or through leaky valves would not be sudden and would have made itself manifest to a careful engineer in time to avoid mishap.

Having located the trouble if it could be remedied within a short time I should try to get repairs made and keep the plant in operation much depending upon the time which had elapsed since it was positively known that water had been in sight in the gage glass as an engineer at all familiar with his plant would be able to tell with fair accuracy when his water level was, provided it had not been escaping through the blow off as first suggested. Should a shutdown be found necessary the engine should be allowed to run to reduce the pressure as far as possible.

1b. But, if the engine is not running do not start it, as starting it would raise the water level and might bring water in contact with red hot metal. Do not raise the safety valve and don't turn on the feed water.

If a firebox boiler, take a look at the crownsheet before the furnace has cooled off and if found to be red hot, the boiler should be cooled down and carefully examined and repairs made if found to be needed, before being fired up again.

2. First find shell surface. The entire surface is found by multiplying the distance around (the circumference) by the length. The circumference of this boiler is 3.1416×4 ft.$=12.5664$ ft. Multiplying this by the length we have $12.5664 \times 15 = 188.5$ sq. ft. Since the question says take one-half the entire shell surface, heating surface will equal $\frac{1}{2} \times 188.5 = 94.25$ sq. ft.

If a table of tube factors is at hand, a glance will show how much surface there is on a foot length of any size tube; but in an examination, such tables are seldom allowed. The surface is found, however, in the same way that we found the shell surface of the boiler—being careful to put all dimensions in the same denomination. To find the number of square feet in the surface of a 4-in. tube one foot long: $3.1416 \times 1/3 \times 1 = 1.0472$ sq. ft. There are 30 tubes, each 15 ft. long, or $30 \times 15 = 450$ ft. in all $450 \times 1.0472 = 471.24$ sq. ft., which is entire tube surface.

Shell surface	= 94.25 sq. ft.
Tube surface	=471.24 sq. ft.
Total heating surface	=565.5 sq. ft.

3. Theoretically a pump will lift water very nearly 34 ft. If the pump could produce perfect vacuum and there were no friction the atmospheric pressure of 14.7 lb. per sq. in. would all be available for raising water to the pump. A column of water one foot high weighs 0.433 lb. per sq. in. Then the height to which atmosphere could lift water if there were no slip or friction would be $14.7 \div 0.433 = 33.9$ ft.

But both slip in the pump and friction in the suction pipe always are present. If the pump is in excellent condition, and the suction pipe short and direct, we may expect to lift water 25 or 26 ft. If the pump is not in prime condition or if the suction pipe runs for a long distance to source of supply or contains many elbows, then a lift of 20 ft. is about all we may expect.

4. A fluid flows only when there is an opening to a region of lower pressure. If a steam valve, communicating with atmosphere or with a low-pressure

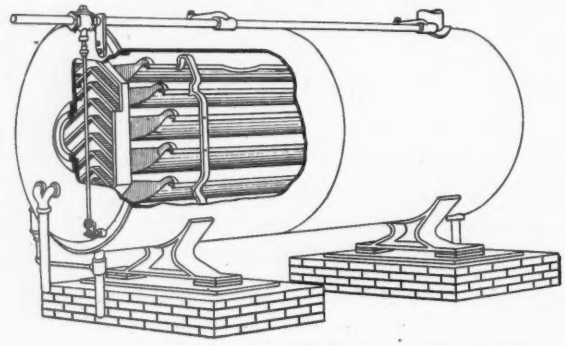


FIG. 1. HORIZONTAL TRAY TYPE OPEN FEED-WATER HEATER

line is opened, steam will flow; but if it is opened to another boiler containing exactly the same pressure there will be no flow. The same is true of water. Attach a long hose to a line containing 20 lb. pressure, open the valve and the water will flow; but if we elevate the nozzle $20 \div 0.433 = 46.2$ ft., we shali have created a back pressure of 20 lb. by the column of water in the hose and water will not flow. To secure a flow of water from a lower level to a pump chamber above, all we need to do is to reduce the pressure in the pump barrel to a lower value than that on the surface of the water. When we have done this, water will necessarily flow.

Now the pressure on the surface of water in an open basin may be taken as 14.7 lb. per sq. in. Suppose we have a lift of 16 ft. Then the weight of the column of water in the suction pipe is $16 \times 0.433 = 6.928$ lb. per sq. in. If now our pump piston were able to maintain a perfect vacuum we should have a difference of pressure between pump barrel and surface of water in basin of $14.7 - 6.928 = 7.772$ lb. per sq. in. and of course water would flow from the higher pressure in the basin to the lower pressure in the pump. Of course no pump will maintain perfect vacuum; but a good pump will approximate it. The office of the pump then is to reduce pressure within itself. Atmospheric pressure does the lifting.

5. Use dilute muriatic acid, soaking injector in this till scale loosens and water ceases to bubble.

Answer 5a is from Harvey Masters.

5a. A little lye made from wood ash, a little acid or some boiler compound and water make good solutions for treating scaled injectors. After treatment take parts out and rub them with a soft piece of wood and emery flower or a cloth over a stick pointed to suit the piece.

6. If we connect 2 pipes to a boiler, one to steam space and the other below the water line, the velocity of the steam issuing from the upper one (under pressure now common) will be about 16 times the velocity of the water issuing from the lower pipe. This fact is made use of in the injector. If we add 7 parts water and thus condense the steam, we have 8 parts water in place of the one part steam, and the steam has imparted all its velocity to this mass of water. The velocity of the water through the injector will not be the same as the velocity of the steam, but will be in proportion to its weight. Since the total water weighs 8 times what the steam did, its velocity will be 1-8 the velocity of the steam. Since the steam has a velocity 16 times that which the water would have if it could back out of the feed pipe—or a ratio of 16 to 1—the water delivered by the injector will have a ratio of 1-8 of that, or 2 to 1; which is evidently sufficient to overcome the outward pressure in the feed line and force water into the boiler. The injector works, therefore, by combining water and steam so as to impart the velocity energy of the latter to the former.

7. In the open heater, the steam comes in direct contact with the water. Some of the scale forming materials are deposited in the heater and provision must be made for cleaning this out. Oil from exhaust steam will make trouble if allowed to enter the feed water, so provision must be made to eliminate all oil. One open feed-water heater is in the form of a cylinder. One head constitutes an oil separator. Steam enters through the head, flows along between rows of pans through films of falling water, and uncondensed vapors pass off through an opening at the top of opposite end.

Water is admitted through a float valve which maintains constant water level, then passes through perforated pipes to the pans. These pans are of such shape and so arranged that the water in passing through the series top to bottom is finally broken up and presents maximum surface to the passing steam. The scale is collected in and upon the pans which are easily removed for cleaning, the head of the heater being removed for this purpose. Water is taken by the feed pump from the bottom of the heater.

8. In the closed type of heater the steam and feed water do not come into actual contact, so there is no danger from the oil in exhaust steam. Either the steam or the water is made to pass through small brass tubes, through the walls of which the heat passes from steam to water. One form of this type is a wrought iron cylinder with upper head bumped of same material. The lower head is of cast iron and is the tube head. The tubes are U shaped, inverted; and since both ends are attached to the same head there is no trouble from unequal expansion. Water enters near the bottom and leaves through opening in top head. Under the bottom head is a steam chamber, divided into 2 parts so that the steam enters one side, passes up through the tubes and down into the other part and on to the atmosphere. There is a handhole in the shell giving access for cleaning out scale; or if necessary the shell may be lifted clear of the tubes.

9. A steam-driven pump may be regulated in 2 ways. The throttle of the pump may be set at proper opening to give desired water level, where pump takes its supply from pond, stream, tank or pipe line.

If supply is taken from a receiver or tank the amount of water entering such receiver or tank may be regulated by hand valve to give desired water level in the boiler and then the pump must be governed by a balanced valve actuated by a float with necessary intervening rods and levers. With a direct connected or belted pump, there should be a by-pass from the delivery line to the suction. By opening or closing the valve in this by-pass, regulation may be secured.

10. A column of water one foot high, (at a temperature of 62 deg. F.) will give a pressure of 0.433 lb per sq. in. (or 62.552 lb. per sq. ft.). The pressure at the bottom of a column of water 85 ft. high would be $85\times0.433=36.805$ lb. per sq. in.

11. The valve of a simplex pump is actuated by an auxiliary piston, which is driven by steam admitted by an auxiliary valve, which in turn is commonly driven by a system of rods and levers from the piston rod. In a few makes of simplex pumps there are no rods or levers but the auxiliary piston has steam admitted to it by the action of the main piston. Such are the Cameron and the W. H. Blake. With these pumps the only means of valve setting would be a modification of the main piston.

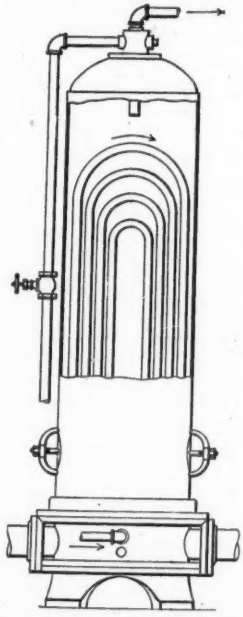


FIG. 2. RETURN BEND STEAM-TUBE CLOSED HEATER

To set the valve of the Deane, Geo. F. Blake and similar pumps there are 2 tappets on the auxiliary valve rod. To shorten the stroke these tappets are moved towards each other, to lengthen the stroke they are moved further apart.

All that can be accomplished in setting the valve of a simplex pump is the regulation of the length of stroke. The stroke should be as long as possible without knocking against the heads. This is to reduce clearance to least possible amount, as clearance is a source of loss. This is especially important in case the pump is the air pump of a condenser.

In case of a Knowles or Warren simplex pump, the valve is set by lengthening or shortening the link between the rocker and the valve rod. In the Davidson, there is a slot in the side lever in which the pin at end of side rod may be moved up to shorten and down to lengthen the stroke.

12. Feed into the bottom. If inlet is placed at the top the pump must always work against the full head, whether stand pipe is full, half full or empty. If inlet is placed at bottom, pump has to work only against whatever head there may be in the stand pipe.

Answer 12a is from J. Coyne.

12a. The inlet should be above the highest water level in the stand pipe so that there would be no possibility of the water leaving the stand pipe in case of an accident to the delivery pipe.

13. The area of a 6-in. piston is $6\times6\times0.7854=28.274$ sq. in. The total pressure upon the steam piston will then be $80\times28.274=2261.92$ lb. per sq. in. It is customary to allow 25 per cent for friction of rods, piston, valves, and water in pipes, etc. The effective total pressure will, therefore, be $0.75\times2261.92=1696.44$ lb. per sq. in. The area of a 3½-in. piston is $3.5\times3.5\times0.7854=9.6211$ sq. in. The pressure against which pump may be expected to work will be $1696.44\div9.6211=176$ lb. per sq. in.

14. Strictly speaking, vacuum is space devoid of all matter. But the term vacuum is used in engineering practice to denote pressures below that of the atmosphere. At sea level, the pressure of the atmosphere is 14.7 lb. per sq. in. At this pressure it will balance a column of mercury 30 in. high. If we should connect this column of mercury to a closed vessel and then pump out air till the pressure were reduced one half or to 7.35 lb. per sq. in., the mercury would at the same time fall 15 in. and we would say we had 15 in. vacuum. If we should reduce the pressure two thirds or to 4.9 lb. per sq. in., the mercury would stand only 10 in. in the glass, and we should have 20-in. vacuum.

The mercury gage is seldom used except in cases where precision is necessary, but the ordinary gages are graduated to read in inches of mercury. The reading is in inches of mercury below the 30 in. that the atmosphere will balance at sea level.

15. There is no difference. Any non-condensing engine may have a condenser attached to it and then be run condensing. Or a condensing engine may have the condenser "cut out" and exhaust to atmosphere. Some slight change might be necessary in the valve setting.

Answer 15a is from H. G. Roberts and 15b from F. F. Damon.

15a. A noncondensing engine is one in which the exhaust steam escapes directly to the atmosphere. The atmospheric pressure acts against the movement of the piston.

A condensing engine is one in which the exhaust steam passes into a condenser and is condensed by cold water and a vacuum more or less perfect is obtained in the condenser and exhaust pipe, thus removing the atmospheric pressure resistance from the piston, which increases the net pressure driving it.

15b. The difference between a condensing and a non-condensing engine is that the former exhausts into a partial vacuum and consequently has but little back pressure, while the latter exhausts into the atmosphere and has a back pressure of 14.7 lb. or less per sq. in. A condensing engine can be 20 per cent smaller and the cost about 20 per cent less than one running non-condensing.

INTERESTING TESTS OF BOILERS ON PANAMA CANAL

HOW A BONUS WAS EARNED

SPITE of discouragements and unforeseen difficulties which are bound to occur in so large an undertaking, the work on the Panama Canal goes steadily forward and steam power is playing a large part in it. At certain points along the route of the Canal especially large installations have been necessary to take care of the heavy work at these points, 2 of these being at the Gatun Dam and at Mira Flores. These 2 installations are for generating electricity to operate cableways in the placing of concrete in the locks and dams and Keeler water-tube boilers aggregating 5000 hp. have been installed to furnish the steam.

BATTERY OF BOILERS AT MIRA FLORES

The lift by means of a series of locks at the Mira Flores construction is a heavy one, the lower locks being 41.5 ft. deep and the 2 upper locks each 30 ft.; all these locks are in pairs, 110 ft. wide by 1000 ft. long, and to construct one set of locks requires 2,000,000 bbl cement, 2,000,000 cu. yd. of crushed stone and 1,000,000 cu. yd. of sand, so that there is a considerable job of toting to be handled by Old Man Steam.

Fuel is, naturally, scarce and of high cost, so that economy in operation of the plant is an essential feature, and the performance of boilers already in service with personal examination of a number of plants and careful consideration of efficiency and reliability was made before the order for Keeler boilers was placed.

In each plant are 6 boilers installed in batteries of 2 each, and erected with special steel casings entirely enclosing front, sides and rear, this casing being lined with 2 in. of magnesia block and 9 in. of fire clay. After completion of the Canal these plants will be maintained for the permanent operation of the locks, so that they have been built more substantially than would be the case for construction work alone.

Specifications

GOVERNMENT specifications required for these plants an evaporative efficiency of 65 per cent when furnishing 17,000 lb. of steam at 205 lb. absolute pressure and 150 deg. superheat from feed water at a temperature of 210 deg. F.

Provision was made that a bonus of $1000 should be given above the contract price of the boilers for each 1 per cent evaporative efficiency above the 65 per cent required. The testing of these boilers was remarkable for the fact that during the test only government engineers were present and neither firemen, engineers nor representatives of the boiler manufacturers were at the plant.

It may be considered, therefore, that the tests are entirely disinterested and in consideration of the bonus proposition at stake the government engineers would take extreme care to see that all instruments were standardized and all items as nearly correct as possible. As a result of the tests each plant was accepted and an efficiency bonus paid immediately on the basis of 82.36 per cent efficiency under the contract requirements.

Test Results

SOME details in regard to the tests are as follows:

The boiler tested was 1 boiler of the installation of 6 rated at 400 hp. and was installed under the conditions that it should have not less than 4000 sq. ft. of heating surface, should give evaporative performance as previously outlined, the draft being 1 ounce induced and the coal used a Pocahontas having fuel value of at least 14,000 B.t.u per pound. The ratio of grate area to heating surface was approximately 1 to 65 and the ratio of superheating to heating surface 1 to 5.

In the preliminary as well as in the final test the coal used was weighed on platform scales in front of the boiler, samples being taken from each wheelbarrow and the amount of coal checked at the end of each hour.

Feed water was pumped direct from the heater into the weighing tanks above the heater, then discharged into 2 small tanks on the floor of the turbine room, from which it was pumped direct to the boiler under test. Account was kept of the theoretical displacement of the boiler-feed pump and it was found that the slippage during the preliminary test was 46.24 per cent and during the official boiler test 41.29.

On March 3, 1910, the trial lasted for 8 hr., the weather being fair and the alternate method of starting and stopping used. Pocahontas coal was furnished in mine run having 1.78 per cent moisture and 2.56 per cent ash and refuse in the dry coal. By calorimeter the coal tested 15,292 B.t.u. per pound.

The grate was 9.15 ft. wide by 7.1 ft. long, giving 64.965 sq. ft. grate area, and the furnace in front was 45.25 in. high and at the rear 39 in., giving an average height of 42.1 in. Air spaces in the grates were 5/8 in., giving a proportion of air space to grate surface 46.87 per cent. The water heating surface was 479.4 sq. ft. and the superheating surface 1084.5 sq. ft., so that the ratio of water heating surface to grate was 62.7. Steam pressure at the boiler was maintained at 188 lb. and at the turbine, which was used as a load, 181 lb. gage.

Force of draft below the damper was 0.412 in. of water and in the furnace 0.306 in., in the ashpit 0.062 in. Temperature of feed water coming from the heater was 200.44 deg. and entering the boiler 183.57 deg. F. Steam from the superheater had a temperature of 481.79 and the escaping gases from the boiler had a temperature of 473.62 deg.

Fuel used was found to be 12,545 lb., which, corrected for moisture, gave 12,321.69 lb. of dry coal. This amounted to 1,540.21 lb. of dry coal per hour, or 18.97 lb. dry coal per sq. ft. of grate surface per hour. Degrees superheating were found to be 98.79 F., while the wetness of steam was 1.0695 per cent. The total water fed to the boiler was 129,218.29 lb., which had to be corrected for the superheat in the steam and for the difference of observed conditions from those stated in the specifications.

Correcting to give the equivalent evaporation for 140 deg. superheat and 190 deg. gage pressure gives 141,455.26, and the factor of evaporation from and at 212, starting with the guarantee conditions is 1.1315, giving an equivalent evaporation from and at 212 of 157,311.87 lb. This reduces to an equivalent evaporation per hour from and at 212 of 19,663.98 or an evaporation per square foot of boiler heating surface of 4.82 lb.

Horsepower developed under the rules of the A. S. M. E. was therefore, 569.97 which is 142.5 per cent of the rated horsepower. The efficiency measured as the heat absorbed by the boiler per pound of combustible divided by the heat value of 1 lb. of combustible was 81.05 per cent and for the boiler, including the grate and changed to the conditions specified for the guarantee, viz., 210 deg. F. and 190 lb. gage, the efficiency figured to be 82.36 per cent.

Coal delivered in the boiler room cost per ton of 2240 lb. $4.25 so that the fuel cost for evaporating 1000 lb. of water was 18.41 cents and the cost for evaporating 1000 lb. from and at 212 was 15.13 cents. Spread firing was used, the average thickness of fire carried being 7 2/3 in. and the interval between firings being 5.23 minutes.

MOCKING BIRD STEAM WHISTLE

By J. Campbell

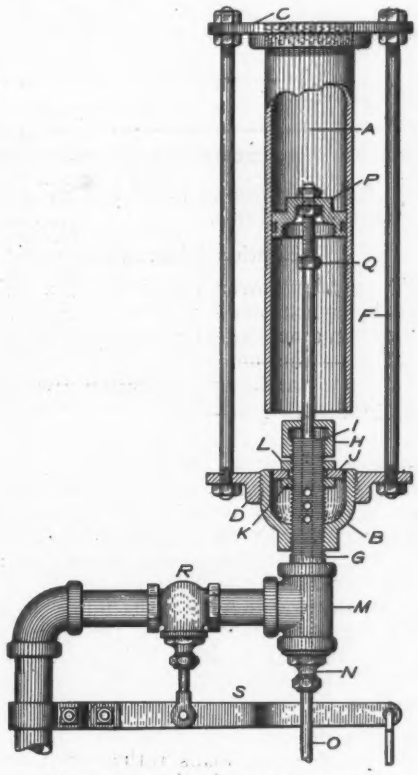
WHILE on a construction job, I made at odd times a steam whistle from old pieces of junk which accumulated in the shop. The first thing I selected was a piece of 3-in. pipe, 16 in. long. This I put in a lathe, and, with a boring bar, bored the inside true and smooth. I then turned it true on the outside, and finished with a file and emery cloth. This was for the bell, A, of the whistle.

For the base and steam distribution I used a 1 by 2½-in. reducing coupling, B, after turning out the threads from the inside, and to a diameter about 1/32 in. smaller than the inside diameter of the bell, A. On the outside of this coupling I cut threads 8 to the inch. Two old pipe flanges were turned up in the lathe to make them as light as possible, one pipe flange, C, threaded to fit the top end of the bell and the other, D, to fit the threads cut on the outside of the coupling.

The flanges were connected with 3 ½-in. bolts having sufficient length to raise the bell from 1½ to 2½ in. from the diaphragm. These bolts were threaded long on one end for the purpose of adjusting the height of the bell.

The steam connection at the lower part is a 1-in. pipe, G, with a thread on one end long enough to reach entirely through the coupling, and have end enough to accommodate a lock nut and a small stuffing gland, H, which was made from the stuffing nut of an old brass valve. The top of the pipe was covered with a washer, I, having a hole large enough to allow a ⅜-in. rod to pass through easily. The long threaded pipe was perforated with ¼ and 5/16-in. holes.

I then turned up a diaphragm, J, from thin metal, to a diameter of about 3/64 in. less than the inside diameter in the coupling B, and made a hole in it that the 1-in. pipe would pass through tightly. This was held in place by lock nuts K and L.



SECTION AND DETAILS OF WHISTLE

The steam pipe, G, was turned into a tee, M, which was fitted with a stuffing gland arrangement, N, made from an old brass globe valve, machined and fitted as shown. This prevents steam leakage around the rod, O, which was made from ⅜-in. round iron and smoothed with emery cloth.

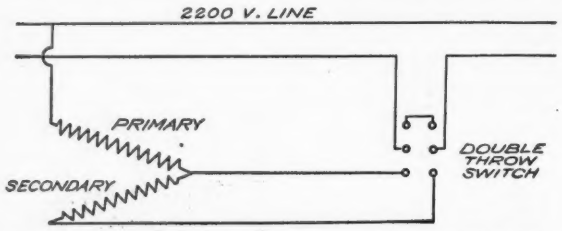
Piston, P, was made from an old 3-in. pipe plug which was turned up and grooved for a cast-iron snap ring. The piston was fastened to the end of the rod O with 2 nuts as shown. The nut Q was placed on to prevent the piston from being drawn out of the bell by striking on the stuffing-gland. The top end of the bell A was hammered in slightly to keep the piston from going out at the top.

The steam valve R was made from an ordinary 1-in. disk valve by turning off the threads on the stem so it could be operated by the lever S as shown. The change of tone is caused by the piston moving up and down in the bell. The piston is operated by the rod O. This whistle has a range of 3 octaves and has a clear and beautiful tone which equals very expensive ones.—Popular Mechanics.

ELECTRICAL KINKS

By R. E. Bradley

A TRANSFORMER has been used successfully as a booster, as shown in the illustration, and although it is not a new arrangement, it may be of interest to some. The transformer must be large enough to carry the main current in secondary coils. This gives a 5 per cent boost on the main line. In



TRANSFORMER CONNECTION FOR BOOSTING VOLTAGE

case the voltage is lowered instead of raised reverse the secondary connections.

Substation Difficulties

DIRECT current power machines at a substation driven by synchronous motors fed into the same lines as the engine driven power machines at the main station. The motor driven generators were used as motors, taking current from the main station, to bring the synchronous motors to speed at starting.

The motor current in the series field winding of the machines overpowered the shunt winding, so that the machines refused to start and produced practically a short circuit on the lines, opening circuit breakers, etc. Switches were placed on the machines for reversing the connections of the series winding at starting. After the motor is synchronized and the generators loaded, the series coils are cut out by means of a single pole switch, while the reversing switch is thrown over to give the proper compounding effect.

It is often desired to run this apparatus through short periods of small loads rather than shut down and start over. When the load drops down as low as one quarter full load, equilibrium becomes unstable, due to the absence of an equalizer, the load all being taken by the main station. Worse than this the generators begin taking current from the lines. The increasing motor current in the series winding of the generator overpowers the shunt winding, causing the torque to pass through zero and reverse, and increase high enough to pull the alternator out of synchronism. The remedy for all this is, of course, to throw the reversing switch to the starting position when the load is small, making proper voltage adjustment by the shunt field. The equilibrium is then stable.

Nernst Lamps on Direct Current

IN using Nernst lamps on direct current the glower always broke off close to the end where it was cemented to the platinum wire after a very short life. By wrapping the plainum wire around the broken end of the glower about 3 times, leaving the ball of cement on the end of the platinum wire, and pressing this ball close into the glower so as to take the greatest part of the heat, lamps of this kind can be made to burn about 700 hr. On alternating current no difficulty of this kind is experienced.

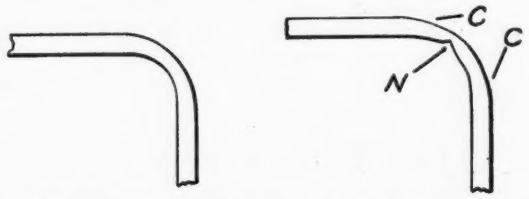
Three-Wire Service

IN making 3-wire underground connections to buildings, either from pole line or underground circuit, use duplex rubber-covered, lead-cased wire for the 2 outside wires, and bare copper, either stranded or solid, for the neutral; all to be run in wrought-iron pipe, either red-leaded or asphalted inside and out. This makes a cheaper service connection than if the 3 wires were all insulated, and also helps to ground the neutral better than is apt to be the case where the only secondary grounding is done by digging a hole at the foot of the pole, where the soil may, or may not be damp at all times.

BENDING PIPE UNDER DIFFICULTIES

IT is a difficult matter to bend pipes at any time without proper appliances, especially at sea, and engineers as a rule have no very clear notion as to how to accomplish this work if they are faced with trouble of such a character. A knowledge of a few ways of doing this work is therefore very useful; as, for example, in cases where it becomes necessary to fit up a speaking tube, say, between the deck and the engine room or from the chief's berth to the engine room. A speaking tube of this nature may be made from old condenser tubes, and this becomes quite easy if the engineers know how to bend such tubes to any required shape.

This is done by filling up the tube with sand and blocking up the ends. If no sand is available, resin



BAD BENDS AND HOW TO TAKE OUT A NICK

will do instead. When the pipe is filled it can be bent to any shape, and if it is not too large in diameter it may be bent cold. Iron pipes above 1 in. in diameter may be bent without sand if care is taken to have the part to be bent maintained at a good red heat. It is hardly necessary to say that, if the pipe is not filled, it will usually go flat at the bend and have a bad appearance, and in the case of condenser tubes they will break or kink. The illustrations show the way the piping becames distorted if it is bent without an internal filling.

In some cases a nasty nick is obtained, as shown in the second illustration. If this should occur in an iron pipe, a method of taking this out again if the pipe is not fractured is as follows: The whole bend CC should first be heated to a good, red heat, and this cooled down all over except immediately at the nick N. The part which is left hot will then come out to its original position. The second sketch shows the parts which have to be cooled CC, and left heated N, respectively.—J. H. Smith in International Marine Engineering.

PRACTICE AND THEORY OF THE INJECTOR

THIRD edition by Strickland L. Kneass, New York, 1910, 170 pages, 53 illustrations, cloth bound, 6 by 9 in. price, $1.50.

Since the time of its invention by Giffard, the injector has been an apparatus which has been of the greatest use, but has been a mystery to many people. Starting with the history of the Giffard injector, the author says: "From the time of his graduation from L'Ecole Centrale in 1849, Giffard had directed his energies to the study of aeronautics and had spent much time in developing a light steam motor for propelling balloons; it is, therefore, not strange that he should also have attempted to devise a compact and convenient substitute for the steam pumps then in use."

From this it is seen that the injector really came to us as a result of the study of flying. Giffard studied the injector problem and on theoretical grounds thought that he ought to be able to force water into the boiler. He made a working drawing and then went to a manufacturer with it. His success is a brilliant example of the use of correctly applied theory. "A model was made by M. Flaud & Cie., of Paris, who found, however, considerable difficulty in forming the tubes in the peculiar shapes required. But in the shape and proportions of the nozzles lay the element of success, and the first instrument constructed entirely fulfilled the expectations of the designer."

Time proved that Giffard had solidly worked out the principles of his invention, and although some changes have been made in details, the injector stands in principle as he first devised it. As with all new things, it did not at once jump into favor. "For stationary service it did not at first become popular; possibly on account of the mystery that seemed to surround its workings, and the general skepticism as to its practical wearing qualities. Some of the contributions and queries published in the engineering papers of the day are very amusing, and a certain writer in one of the most prominent weeklies proves most conclusively to his own, and probably to some of his readers' satisfaction, that the new method of feeding boilers was an absolute impossibility."

Spite of the prejudice against it, the injector made headway, until now it is the most popular feeder in use, taking into account all classes of steam propelled machinery. Chapter 2 of the book takes up the development of the principle of the injector, showing that the curves of the tubes and nozzles as laid down by Giffard were beyond criticism, and are still used when this type of injector is manufactured. But development has taken place in constructive changes, in carrying out the ideas of Giffard and in the discovery of new properties of the jet.

"Genuine mechanical ability is seldom combined with inventive genius, and it almost always follows that the fullest development is obtained in other hands than those of the original inventor. The first improvements were, therefore, in the line of correcting the defects that became apparent after the injector had been subjected to the test of actual service."

The first form of the Giffard injector is shown and fully described with the use of each part, and the history is narrated of the defects in mechanical construction which were discovered, and of how these were overcome by successive attempts, and how the instrument was simplified as it came to be more familiar to the makers and the users. Different types, including the Sellers, the Korting, English types, and those developed in the United States, are shown in the remainder of the chapter 2, and in chapter 3 the function of each part of the injector is taken up in detail.

First it is stated that "an injector is a jet apparatus in which the cross-section of the discharge nozzle of the actuating jet is greater than that of the receiving tube. An ejector reverses these conditions, and the gaseous or liquid discharge will freely pass through the delivery tube." Follow the definitions and the discussion of the functions of the delivery tube, combining tube, suction tube, steam nozzle, overflow, single and double jet injectors, open and closed overflow, and the terms relating to performance. Certain parts of the injector are so important that it is necessary to give them even more extended consideration, and chapter 4 is devoted to the delivery tube. "The function of this

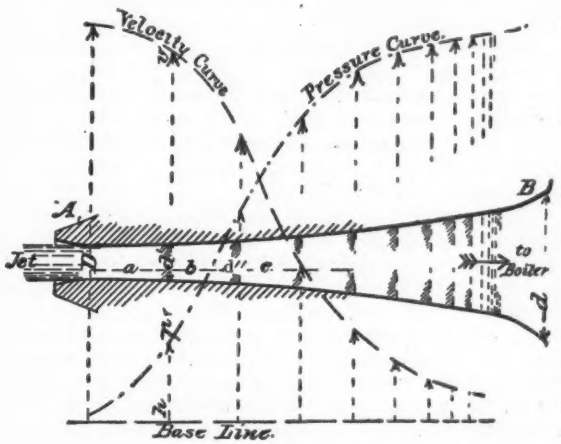


FIG. 1. CHANGE OF VELOCITY TO PRESSURE IN THE DELIVERY TUBE

tube is to transfer the energy due to the velocity of the water and condensed steam, into pressure in the boiler pipe. The quantity of water delivered by an injector is directly dependent upon the minimum area of this tube, and under the same conditions varies with the square of the diameter."

Following the discussion in regard to the capacity some problems are worked out to show the capacity of different proportioned tubes, and in connection with this is given an interesting illustration showing how the velocity decreases as the pressure increases as the jet passes through the delivery tube of the injector. This is so instructive that it is thought worth while to reproduce it here.

After this is shown the effect of different forms of delivery tubes, and it is explained why the particular form as indicated gives the best results, and an equation of the curve for the form of the tube is worked out. This involves some mathematics and it is necessary for the average man to accept this curve as being right without following the methematical discussion. The advantage of getting this curve just right is that it avoids any wasted energy and when the curve rises easily from the low pressure at the throat of the tube to the final boiler pressure in the end, the wear is distributed so that it is very small. It is shown that in spite of giving it the best possible shape, grit and dirt in the feed water will cut the mouth of the tube, and this tube is the one which usually wears out first, but the author states that by a little judicious management

and reaming or smoothing out the roughened places, the life of the injector may be much prolonged.

Chapter 5 takes up in detail the combining tube. "Unfortunately the action of the steam in the combining tube is not so definitely understood, and the most that can be done is to describe the phenomena as observed, and deduce a few general conclusions. It follows, therefore, that there may be as many different forms as there are manufacturers, and to a great extent this is true, each type of injector operating more or less successfully under a certain range of conditions."

"It is this tube, in great measure, that governs the mechanical efficiency of the injector. In the first place, assuming a constant head of feed water, the cross-section of the upper end, by regulating the quantity of water that may enter, determines the proportion of water to steam in the resultant mixture, and the temperature of the delivery.

"Second, the convergent taper or curve extending from the end of the steam nozzle to the lower overflow should, in order to obtain the maximum efficiency from the injector, conform closely to the rate of condensation of the steam, and its length be modified for every variation in the pressure of the steam or the temperature of the feed."

Giffard and the early experimenters appreciated these facts and laid much stress on the necessity of an adjustable combining tube. The author goes on to describe the effective action of an injector working into a boiler under normal and efficient conditions, lifting the feed water one foot and running at maximum capacity, and shows how the injector may fail in action from various causes. He then takes up a series of experiments which illustrate these conditions, and where the following results were obtained:

At a steam pressure of 120 lb. the distance of the combining tube from the upper end of the stroke was at maximum capacity 24 millimeters, and at minimum capacity 3.5 millimeters; at 90 lb. maximum capacity distance was 15 millimeters, and the minimum 1 millimeter; at 60 lb. the maximum capacity was 7 millimeters, the minimum capacity .5 millimeter, and at 30 lb. the maximum capacity 1.5 millimeter, and the minimum capacity 0.5 millimeter. "The wide difference between the position of the combining tube at 30 and at 120 lb. steam show how impossible it is for a single jet injector with fixed nozzles to work thoroughly efficiently over a large range of pressure."

All this shows the necessity of an adjustable combining tube, if an injector is to work over a wide range of pressures, although this adjustment may be made self-regulating, and should preferably be made so where the steam pressure is liable to fluctuate widely.

"The form of the combining tube as determined by various experimenters differs greatly; in the tests of the Irwin injector by a committee of the Franklin Institute, in 1879, a tube was used whose length was only 4 times the diameter of the delivery tube; this is a great contrast to that of the exhaust injector, where the ratio is 18 to 1; this corresponds to the usual practice for high-pressure steam, where the increased quantity of heat requires provision for its absorption, and this can best be accomplished by lengthening the tube, and giving better opportunity for intimate mixture between the water and the steam."

From this point the vacuum in the combining tube is discussed and the method by which such vacuum is obtained; also the conditions which lead to greatest efficiency. It is noted that variations in capacity of 75 per cent, and temperatures as high as 162 deg., have been obtained in experimental work by forms of the Sellers' fixed nozzle injector with varied forms of tube.

"The advantage of maintaining the feed water pure and free from lime and dirt is more apparent in the case of the combining tube than with any other part of the injector. The tendency is not only to enlarge the diameters at different points, but also to change the shape by wearing and grinding off all shoulders against which the jet can strike. Tubes that have been used with impure water show this feature very strongly, and the conical shape is frequently changed to that of 2 cylinders, connected by an abrupt shoulder. The force of the impact of the jet of steam is so severe, that a tube with walls 3/16 in. thick was found to have a pocket ⅛ in. deep worn in it at the end of the steam nozzle, and the outside was considerably bulged by the continuous blows it had received."

The third in the trio of important parts of the injector is the steam nozzle. While the principles of action of this nozzle have previously been discussed, the experiments which were used to show the action of the steam nozzle and of a steam jet are given and are interestingly illustrated by a figure which is here reproduced.

"Sketches and instantaneous photographs were taken of jets of steam discharging into the air, and the form of the jet and the direction of the motion of the particles were carefully noted. The results are given in Fig. 2, which accurately represents the external form assumed by the jets. In all these experiments the jet, after leaving the end of the nozzle, was almost invisible for a distance of 2 or 3 diameters, and of a pale bluish color, marked with light lines of white, apparently produced by the entrained particles of water. Beyond the transparent portion, the jet expanded to a much larger diameter, became white on the surface, and was finally condensed by the cooling effect of the air."

The difficulties shown by the figures are discussed, and as is evident from the figures the divergent curve, No. 4, is found to be the one with the highest efficiency. A great number of curves and graphical discussions are introduced, showing the loss from various imperfections in the steam tube, and the effect of water in the steam is also discussed. "Besides retarding the velocity, entrained water has an injurious effect upon the surfaces of the tubes, cutting and abrading the metal wherever soft spots occur; dry pipes should be used to prevent this trouble and all pockets or depressions in the steam pipe avoided; for prompt starting, efficient action, and general reliability of an injector are much enhanced by attention to this apparently trivial condition."

Area of steam nozzles depends upon area of delivery tube, since the latter is what determines the amount of water to be handled by the injector. The problem is to handle the greatest weight of water possible with the smallest possible weight of steam, and while raising the temperature of the feed water is beneficial, this is not the prime object of the injector, and it is shown that while the actual amount of power used in feeding a locomotive boiler which requires 2500 gal. of water an hour amounts to 65 hp., if steam is used to best advantage, this may be reduced to 45 hp., the temperature of the water entering the boiler being lowered approximately 25 deg.

So much for the details of the injector. As to the action of the injector, here comes the mystery which has puzzled, and to get the simplest possible method

for considering injector theory, the author looks at it solely from a mechanical point of view; "simply as an apparatus in which the momentum of a jet of steam is transferred to a more slowly-moving body of water, producing a resultant velocity sufficient to overcome the pressure of the boiler."

He shows that if a nozzle is connected to a reservoir having steam at 120 lb. pressure, and discharges 1 lb. of steam per second, at its minimum diameter the steam will have a velocity of 1407 ft. a second, but if the terminal pressure is a vacuum of 22 in., the velocity will be 3446 ft. a second. Then, if the condensation in the combining tube is such as to produce 22 in. vacuum, or 4 lb. absolute pressure, the steam will be reduced to a solid jet of water with a cross-section 1/774 the area of the steam while passing

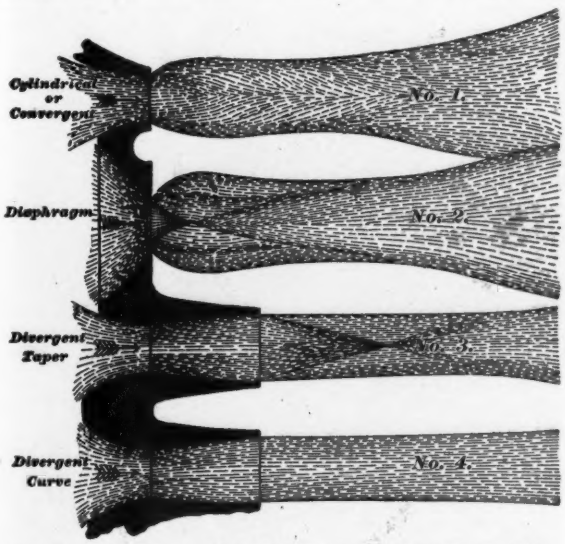


FIG. 2. ACTION OF THE JET FROM DIFFERENT SHAPED DISCHARGING TUBES

through the steam nozzle, and as the contraction of the jet is lateral, the velocity is not affected, and is still 3446 ft. a second.

If the action of the injector were reversed, and a jet of water forced from the boiler through the delivery tube by the boiler pressure, it would have a velocity nearly equal to that due to the head, or about 133 ft. a second, only 1/25 that of the jet of condensed steam. It is evident, therefore, that by introducing cold feed water which will help in producing the vacuum of 22 in. in the combining tube, this water will be carried with the jet of condensed steam, and the 2 fluids will move along together through the delivery tube with a terminal velocity greater than that of a jet of the same density, issuing from the boiler. If the amount of water supplied to the steam jet is too great, the velocity will not be sufficient to overcome tnat due to boiler pressure of 133 ft. a second. If the water supply is too small, the volume of steam will not be condensed sufficiently to pass through the tubes, and in neither case will the injector work properly.

After this is a series of examples following the steam in its whole course through the tubes, and showing just what the action is of the change in velocities, and at the end, after having shown the method of calculating the efficiency of the injector as a mechanical device, a comparison is made with the direct acting steam pump, showing that for a boiler which is required to deliver 3000 lb. of steam an hour at 80-lb. pressure, and to evaporate 10 lb. of water from and at 212 deg. per pound of coal, with water supplied at 63 deg., the saving of coal when the boiler is fed by the injector over feeding by the direct acting steam pump would be 1.3 per cent.

Variation of the form of the injector with the use to which it is applied and the details of the various American types, such as the lifting and non-lifting, the position of the injector when feeding locomotives, and for other uses, the details of the Nathan and Sellers, the Schutte, the Ohio, the Hancock Inspirator, the Penberthy, the restarting injector of various kinds, the Rue injector or Little Giant, the Metropolitan, and other types are given.

Knowing how the injector works, and having decided to use it, the question arises, how big? "As has already been shown, the maximum capacity of an injector depends upon 3 factors: Steam pressure, height of lift, and temperature of feed water. It is upon the design of the tubes and the special type of the instrument that the extent of the variation depends when any 2 conditions are given and the third altered."

The discussion in the book shows that judgment or experiment must be used to determine the capacity of an injector for conditions differing from usual practice. The manufacturers' tables give the conditions for which an injector is suited, and when asking for special conditions the sizes to be submitted are capacity in cubic feet per hour, steam pressure, height and lift, temperature of feed water, and other spcial conditions, such as length of suction pipe, excess of back pressure, as when feeding through a heater, and anything which may help in determining how much work the injector will have to do. How to obtain these different values is then shown, and the probable causes of any failure of an injector to live up to the conditions for which it is designed.

In the latter part of this chapter is given the method of testing an injector; also the results from a number of tests. The effects of variation in steam pressure was determined by tests; also how hot the water could be and still have the injector work satisfactorily. "It has been found by the experimenters that the effect of admission of air to the suction pipe of all injectors which adjust their capacity to suit variations in the steam pressure is to break the jet immediately and to cause the steam to blow back through the hose into the tank."

Final chapters of the book take up the requirements of modern railroad practice, the advantages of an efficient injector, the economy of feed water heating, scale bearing water, and how to remove the scale from injector tubes. Enough extracts have been given to show that this book is a most valuable one; that it is written by a man who knows what people wish to find out about the injector, and who knows the things which he is trying to tell. It is no exaggeration to say that this is the best book which has been written on the injector, its theory and its operation.

BY THE DECISION of the U. S. Circuit Court of Appeals, Judge Sanborn sitting, announced on Sept. 19, a decree of the Circuit Court for the Southern District of Iowa is affirmed in the case of Warren Webster & Co. vs. C. A. Dunham Co. The suit was for injunction and damages on account of the alleged infringement of patent 454964 and the bill of complaint was dismissed and decree entered in favor of the Dunham Co., thus ending a 4-years' litigation.

REDUCING THE LABOR COST IN A POWER PLANT

By Henry Harrison

EVERY owner of a power plant is interested in the reduction of his operating expense. The figures indicating the production as compared with the operating costs, usually differ where the cost of the power plant increases during the winter months. Usually in the fall, the engineer is consulted as to ways and means for reducing the cost of operation. The payroll is carefully scrutinized and it behooves the engineer to discover a method to reduce his expenses.

If the cost of handling the coal is reduced to the minimum, it behooves him to discover a method for handling the accumulation of ash. There are certain seasons in the year when the ash may be disposed of at a profit, but during the winter months usually the

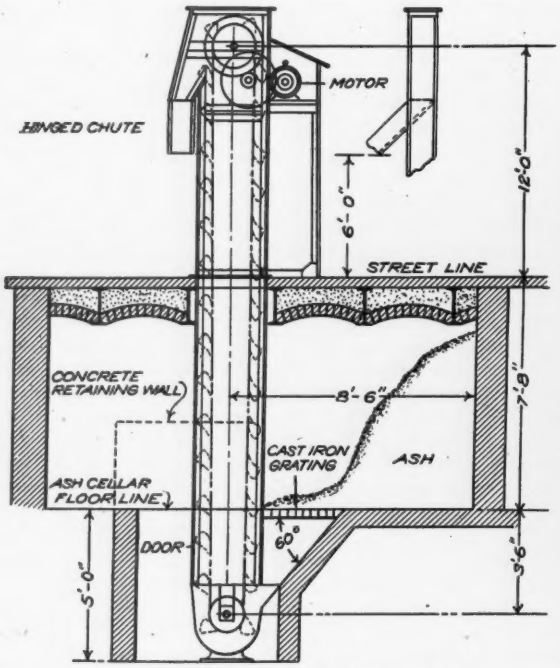


FIG. 1. SECTIONAL VIEW OF ASH ELEVATOR IN PLANT OF LILLY MFG. CO.

ash is an expense and the labor in handling it is quite an item. Quantities of ash are consumed in cement pavements, as well as for fire proofing and concreting. In other places, it is simply used for filling in, wheeled out on a dump and in the spring carted away.

A very unique and practical system was recently installed in the power plant of the Lilly Manufacturing Co., Columbus, Ohio; for several years past, this concern has stored the vast quantities of accumulating ash in a cellar under the alley pavement, adjoining the boiler room. Owing to the storage capacity being limited, it was obliged to employ 2 extra men with a wagon to remove the ash. The total cost per wagon load amounted to $1.50. After a period of time, it was discovered that this method was particularly bungling and inconvenient. One man was usually situated in the cellar, shoveling the ash through a man hole into the roadway overhead; while another man was obliged to shovel the ash into a wagon from the alley pavement. The process of hand shoveling was, therefore, a double one, as the ash had to be hauled away by a wagon.

The company, tired of this unprogressive arrangement, installed a conveying system. The accompanying illustration shows the method adopted for handling this ash, employing a Jeffrey bucket elevator. This elevator measures slightly over 23 ft. between centers and consists of Jeffrey Hercules chain with 32 malleable iron buckets attached to it and provided with a concrete boot, or "loading leg" on a level with

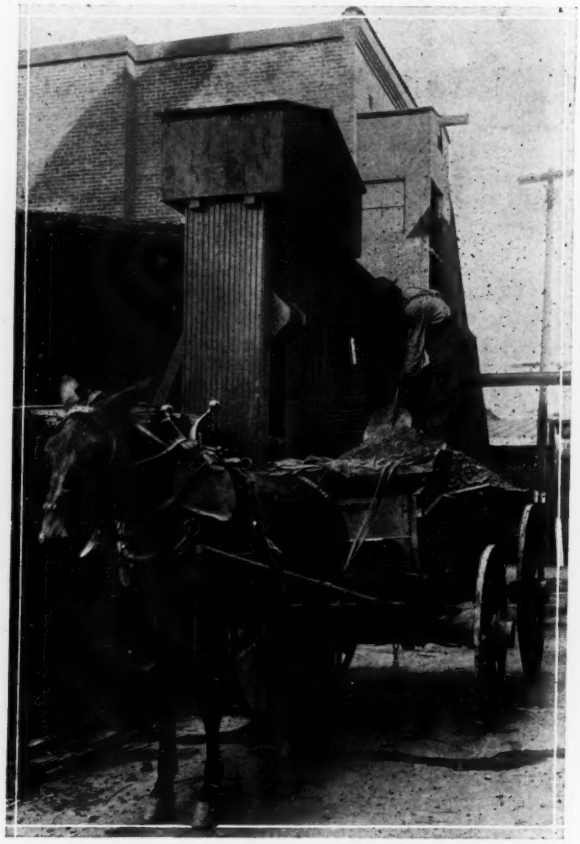


FIG. 3. DELIVERY END OF ASH ELEVATOR

the floor line of this ash cellar at the loading point. This boot is provided with a cast-iron grating, or screen, preventing large clinker from entering the elevator and choking it. The clinker is laid aside and easily mashed and afterwards delivered to the elevator. The elevator is directly connected with spur gearing and driven by a 3-hp. electric motor.

Figure 2 shows a flash-light view of the cellar; a brick wall having been constructed around one side of the conveyor to enable the ash to be piled up.

Figure 3 shows an outside view with a wooden casing protecting the elevator and the method of chuting the ash directly to the wagon. The chute is hinged, allowing it to be dropped out of the way on account of the narrow passage way. This elevator has a capacity of loading 5 cu. yd. of ash in less than 20 minutes.

IMPROVED (?) METHODS OF BOILER INSPECTION

TWO novel methods of boiler inspection have been brought out recently by no less an authority than the Hartford Boiler Inspection and Insurance Co. through its publication The Locomotive, but in neither case does the company stand behind these methods with its recommendation. They are given as methods used but perhaps not to be praised. One of them is an incident which came to the attention of J. M. Allen, the late president of the Hartford Co., and to quote his narrative is as follows:

"A few days ago, our editorial meditations on the subject of boiler explosions were interrupted by the entrance of a stranger, who inquired (in a manner indicating the performance by him of an unpleasant duty) respecting the whereabouts of our inspector. Quoth he, 'I've got a small boiler in use out here in ——— (naming a village not many miles away), which

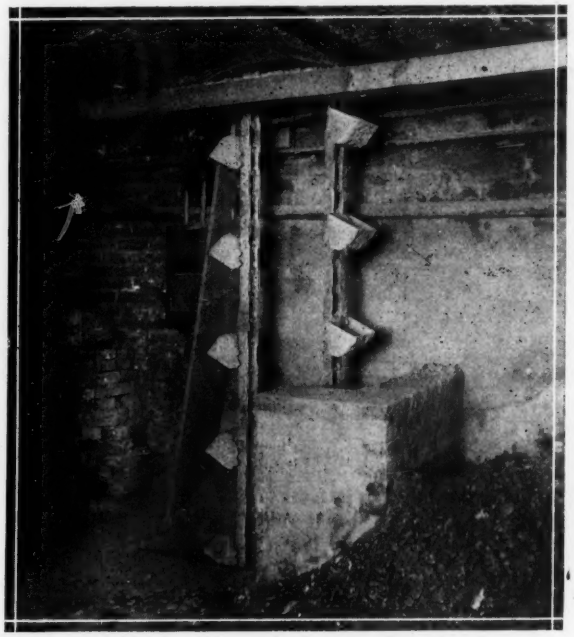


FIG. 2. CELLAR OF THE LILLY MFG. CO.

I s'pose I've got to have inspected, as the law makes me liable to a fine if it ain't done. So I called in to see about it.'

"We gave him the information he desired, and then he volunteered this opinion: 'I don't consider this inspection wuth anything to me, for I've had my boiler inspected by a higher power.'

"'Ah! have you? How is that?' we asked, with a desire to learn of any improvement that might have been made in our line of business.

"He replied with the air of a man communicating an important fact, and standing forth in the calm consciousness of a superior intelligence, 'I had a clairvoyant examination of my boiler a few days ago, and the medium told me it was all right—clean and nice inside, and safe to run.' So saying, he withdrew, and left us in deep thought."

Examination by means of a clairvoyant second sight certainly has advantages so far as discomfort is concerned over the method of crawling into the furnace and through the manhole.

Another incident came to the attention of a solicitor asking for flywheel insurance, and the prospective purchaser of such protection inquired what kind of inspections were made, the conversation running somewhat as follows:

"Do you give buggy inspections or shovel inspections?"

"We will give either or any other kind of inspection that you want, but I am not familiar with the 2 styles that you specify and you would please explain just what they are."

"Well, a few years ago we had visits from an inspector who came around with a rig and when the horse was particularly restive or the man's rheumatism was bothering him a good deal, he gave us a buggy inspection. He drove up to the engine room and whistled to attract the attention of the boiler attendant, and when the man of the scoop shovel appeared, Mr. Inspector asked him a few questions, which being satisfactorily answered the rig appeared in front of the office and the occupant again whistled. When somebody came from the office he received an inspection report.

"Other times, when the horse was quiet and would stand without hitching and when the rheumatism was not particularly bad, the inspector would go into the boiler room, open the furnace door and poke at the bottom of the boiler with a long handled shovel. If the crown sheet seemed reasonably solid and the shovel didn't go through it, everything was assumed to be all right and the certificate was given accordingly."

The representative of the Hartford Co. naturally had a rather sinking at the pit of the stomach at this news and especially when he was informed that the boilers were at that time insured by his company. But the owner relieved his apprehension by saying: "It is true I was insured by the Hartford, but these particular inspections were made by the state inspector and it was a long time ago."

Needless to say, such practices are not now common, even if they ever occurred.

FINISHING A BEARING

By Herbert Charles

AFTER babbitting a journal, trouble is sometimes experienced in making it run cool, until it has worn down to a bearing, especially if it is overloaded or running at a high speed. The following is a quick method of bringing the box and journal to a perfect bearing:

Leave the top cap of the box off, run the journal up to speed without load, keep a small amount of oil running on the journal, and with a cake of sapolio held on the journal it will be but a short time before there is a good bearing.

When the journal shows bright the whole length of the box the sapolio has done its work, and then with the journal running, slush out with plenty of oil and the bearing will be found to run cool when the load is put on. I have seen this method used on engine journals up to 3500 hp. with the best of results.

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AFTER WOOD WHAT?

Disappearance of the timber supply within a generation seems certain, and rising prices will make it a luxury long before that time. What is to take its place and shall we be better or worse off than now?

For construction where lightness combined with strength is needed, and where rapid working is necessary to low cost, wood seems essential; but is it? We have thought the frame building the cheapest, but the figures of government experts show that in 1 year the loss by fire was almost half the cost of new buildings erected, largely due to frame construction and avoidable by building fire-proof structures. Cost of concrete construction is now estimated at 20 per cent above that of wood, so that as a whole the wood construction is a losing proposition. The reduction in insurance premiums is nearly if not quite enough to pay the interest on the extra cost.

Pressed steel in tubular and girder forms is being adapted to all sorts of uses where wood has reigned supreme, and if kept painted avoids decay, shrinkage and cracking. As evidence note our umbrella rods, steel cars, doors and casings, even furniture.

Only where fine finish is desired are we still driven to use wood. A steel construction finished in a vain attempt to imitate wood is an abomination. But with wood released from ordinary building, and machine use, the supply will last a long time yet for finish work.

Steel and concrete with hammered copper, brass and iron for ornament, seem to offer all the substitute needed for the "after wood" period.

COMPARATIVE COSTS

To those about to install power machinery, either in new plants or in remodeling old ones, the question, what kind of power is of vital interest. Someone has defined good engineering as "making a dollar of expenditure produce the largest possible results," and certainly that applies well to the planning of power installations. While it is certain that no general rule can be given or statement made as to the best type of apparatus without careful consideration of the circumstances of each individual plant, figures making comparisons for a given case are always instructive because they give a hint as to the probable comparison for similar plants.

Frequent comparisons have been made for large installations between the reciprocating engine, the steam turbine and the producer gas engine, but comparisons for medium sized plants are not as common and some interesting data have been prepared by F. W. Dean in the course of a report as to the plant for a packing factory in which the figures show not only comparative costs but also the cost per horsepower for each type of prime mover.

The total power to be provided for was 1000 horse, and an interesting fact in the comparison as made is that a single Corliss engine was designated, while in the case of gas engine and steam turbine plants 2 300-kw.

units were specified in each case. Just why this should have been done it is difficult to see, as it would seem that flexibility of plant should have been provided for in the Corliss installation as much as in one of the others.

The total cost for the installation per indicated horsepower was, for the reciprocating plant, $69.75, for the producer plant $67.50, and for the steam turbine plant $57. In the reciprocating plant, fixed charges were made at 13 per cent to include interest, taxes and depreciation, making $9.07 per horsepower, attendance at $3.21, oil waste, etc., 20c, or a total of $12.48; and coal at $2.75 a ton was estimated to cost $6.71 per horsepower on a yearly basis of 310 days at 9 hours a day, giving a total cost per horsepower year of $19.19 for the reciprocating plant.

For the gas producers the fixed charges were taken as 14 per cent, although why this should be done is not specified. The depreciation would be somewhat greater than for steam but interest and taxes would be supposedly on the same basis; it may be that the 1 per cent additional was supposed to take care of more rapid depreciation. This gave $9.45 per horsepower year for fixed charges, $3.21, the same as the steam plant for attendance, and 50c for oil waste, etc. Coal cost was taken at $4.02 per horsepower year for coal costing $2.25 a ton and asuming 1.5 lb. of coal per horsepower hour. This made the cost per horsepower year for the producer gas plant $17.18.

For the steam turbine plant, as previously stated, the total cost was $57 per horsepower, which at 14 per cent gives $7.98 per year, while the cost of attendance would be the same and the cost of oil waste, etc., practically the same as for a reciprocating engine. Assuming the cost of fuel to be the same as for the reciprocating plant, gives $18.10 as the cost per year per horsepower.

In the case of both turbine and reciprocating engine the steam could be used for other purposes, so that part of the cost might be charged off against the rest of the plant, and Mr. Dean has estimated this as approximately $1, leaving the reciprocating engine at a net cost of $18.19 a year and the steam turbine $17.10, gas engine $17.18 per horsepower per year. It will, of course, be understood that this comparison applies only to plants situated as are figured on both as to condition and location, because fuel prices as well as cost of labor and possibilities of utilizing exhaust steam vary materially. For instance, another estimate for a location some 500 miles from the one just mentioned called for a cost of $12 per horsepower on the boilers, whereas Mr. Dean's figures are $7.50. Mr. Dean's figures called for $12 per horsepower of dynamo in the case of the Corliss engine units, while the other plant called for $13.50. Mr. Dean's figures call for $7.70 for the producer, while in the other plant the cost was $13, and in the matter of gas engines Mr. Dean's figures were $21 per horsepower while in the other plant they ran at $41 per horsepower. All these things depend on the type and size of machinery, the location of the plant, cost of labor, and the service required.

The important thing is that for a given set of conditions there is some one best installation. The margin of superiority may not be great in some instances, but if carefully considered the margin will be found and a substantial saving can be made during the life of the plant by taking care that the right kind of power and the right type of prime mover and the right size of plant are provided.

THE STUDY HABIT

Right now is the best time to get it. The crisp nip in the air of an evening inspires to good work and journal and lamp invite to the attack. A little self-control, a little stick-to-it at first, and the habit is soon formed. Did you ever feel the exultation of conquering a problem that has bothered, or mastering a new subject? If you have the habit active, this call is not for you. If you never had it or have drifted away, the coming winter holds new and renewed pleasure for you. Get busy!

James J. Hill says: "No man knows what he can do till he tries—and very few men try it out," which is why the few win big success. One hour a day is 24 hours a month—3 working days. That is 36 days a year—6 solid weeks of full time study. Would you not think you could get enough knowledge to make you more valuable if you were offered the next month and a half, expenses paid, to study a new line of work?

How to begin? Take the issues of Practical Engineer and any books you may have and start today at reading all you can find on some subject that you want to know about.

If you don't find what you want, write us about it. Keep at it; don't be a quitter and a coward because you are a little restless the first week. Stick for a month. Then look back at what you have learned and decide if it hasn't been good fun and well worth the time and effort.

Besides, it pays. A man who rose in 7 years from a yard laborer to the head of a concern employing 3500 men by just this course was aroused by the jeer of his old foreman, "Thar's ingineers lookin' after the machinery; men who've got idication and brains. Phat d'yez know about mechanics?" And another who came from a clerkship to be general manager of a house doing forty millions of business a year makes this stinging accusation against laziness. "There are lots of men who have good brains, but they kick because their employers do not immediately recognize the quality; and they waste, sometimes long lives so kicking instead of getting the idea that it is up to them and nobody else to put the brain at work and make it earn its value. They'll give just so much of it as will earn the salary they receive and devote the rest of their power and energy to some fad or special amusement."

In the ordinary course of events a man must earn advancement and a raise in salary before he gets it. But you can get the study habit now. The first business commandment is, "Thou shalt not wait for something to turn up, but thou shalt pull off thy coat and go to work." Decide what you need most to know more about; then go for it.

Announcing the January 91

ENGINEERS who have been waiting for the announcement of the specialized January, 1911, issue, will read this notice with great anticipation.

No need to tell you that the January issue will surpass all previous specialized numbers, for each year's January number has surpassed its predecessor and the January, 1911, issue will be no exception.

It will contain more up to date information on all phases of power transmission than ever published in any magazine before.

Power transmission, next to power generation, is the most important business of the power plant engineer. After all possible economies have been adopted in the making of power, it has to be transferred to the point where it is to be used, and in this transfer much or little may be wasted according to the care taken to avoid loss. It is not infrequent to find plants where, through adoption of methods poorly adapted to the work or through careless installation, or through lack of care, from a quarter to two-thirds of the power generated is thrown away.

In many plants this transmitting apparatus is in the care of the engineer and in nearly all plants he has considerable to do with caring for it. In any case it is of the greatest importance to him that the transmitting system should be well designed, installed and cared for, since its condition directly affects the record which he can make for low cost of operation of the power plant. If, in a given factory, 100 horsepower is required to drive the various machines and half the power generated is lost in transmission, then the cost for running the power plant in coal, water and up-keep and depreciation on machinery will be just double what it should be.

Methods employed for transmitting power are classified into belting, rope and chain transmission, toothed gearing, the flow of fluids including steam, compressed air and water under high pressure, and electrical transmission. These are adapted for different purposes and different locations. It is now well understood that belting, rope transmission and gearing are suitable for short distances and for moderate powers, while the flow of steam and compressed air, and electrical transmission are suitable for longer distances and larger powers.

BELTING

Taking up the different methods in detail, belting is first discussed, showing what belts can do, the different materials from which they are made, how to select belts for different purposes, what should be specified in ordering belts of any material, and how tests are applied to make certain that the belting fills the required specifications. After knowing what kind of belts ought to be used comes the question of how large they should be, both as to width and thickness, the proper speeds at which to run them, the kind of pulleys best adapted to go with different belts, the method of determining how long the belts should be, how tight they should be stretched, how often they should be taken up, when to use idlers and when not to, how to care for the belts to get the longest life. All these points are of the greatest importance. Over-tight belts are responsible for cut bearings, for cracked belts, for excessive friction, for sprung shafting, while belts which are neglected and allowed to become loose are responsible for loss of power through slip and for the cutting down of production in the factory.

PULLEYS

Pulleys go with the matter of belts, and the proper proportions of pulleys, proper pulley speeds, placing of pulleys for shafts at different angles, use of idlers, fast and loose pulleys, arrangement of belt shifters, the treatment of pulley surfaces and the effect of such treatment on power transmitted, the use of split pulleys and of bushing systems for ready replacement and changes are all given in detail.

SHAFTING

Then comes the matter of shafting, materials which are properly used for shafting, the right sizes to carry the bending load due to the weight of the pulleys and the pull of belts, twisting loads due to the transmission of power and the combined load due to both forces, the proper distance between supports for countershafts, main line shafts and prime mover shafts, the proper speed for operation of shafting, bearing surface required in the boxes, methods of joining shafts by couplings, keys, the use of collars for locating shafts properly, angle couplings for shafts out of line, the best methods of lining up, the supporting of shafting, including different forms of hangers, boxes and bearings, such as rollers and balls; babbitting of boxes, the use of special bearing metals, proper lubrication of shafting to insure the best economy, including the use of greases and oils, graphites and other lubricants, all these are vital points in the proper arranging of a belting or rope drive system.

ROPE DRIVES

For longer distances than can readily be handled by belting and for awkward turns the rope drive has advantages which cannot be disputed. Two systems of rope drive are in common use, the steel wire rope and the fiber rope, either of manilla or cotton. Both systems are fully described, the method of estimating the size needed for a given amount of power is shown in either case, and the methods of installing main drives, secondary drives, tightening mechanisms and the proper proportions of shafting, sheave pulleys, winding drums, ropes and other apparatus is given, also the methods of lubricating and caring for the ropes, and how to splice ropes properly.

911, Specialized Issue

CHAIN DRIVE

The chain drive, its proper uses, dimensions for chains and sprockets, speeds of running, power transmitted and special forms on the market are also fully treated, showing the advantages of this system for certain uses.

TOOTHED GEARING

While the application of toothed gearing in power transmission is somewhat limited, its chief application being in machines which use power rather than in transmission, there are certain places where this method of transmission is by all means the best. Conditions where toothed gearing can be used to advantage are explained, the different systems of designing toothed gears are shown, proportions of teeth, proportions of wheels, method of developing tooth outlines, the capacities of gears and the proper method of setting are given.

STEAM PIPE SYSTEMS

One of the most common methods of power transmission is the flow of steam through piping; while this is largely a method of transmission used within the power plant, it is nevertheless a most important one, as it is used for transmitting the power from boilers to pumps, engines, elevators and for industrial purposes, and it is important that the piping system should be so installed as to waste the least possible amount of power both in condensation and drop in pressure. Careful attention is, therefore, given to explain the requirements of a piping system.

COMPRESSED AIR

Transmission by compressed air, while largely of special application, is nevertheless of great importance in many lines of work and is becoming increasingly so each year. It is, therefore, necessary that the entire question of compressed air should be taken up and treated carefully in connection with this issue. Beginning with the air compressor cylinder, which is really a part of the transmission system, the details of construction of air compressors, requirements for good economy, intercooling of air, the proper pressures for different distances of transmission are points about which the most complete information is necessary and is here furnished. Then to get the air after compression through the piping system in the most economical manner and to distribute it by means of air hose, to reheat it if necessary before sending it to the different motors, are points which have vital bearing in the economical operation of a compressed air transmission. The efficiency of such a transmission may be made high or low, according to the care which is given to these details.

ELECTRIC CIRCUITS

In electrical transmission we are so used to having our attention called to the high voltage long distance success that we forget sometimes that the greater part of the power transmitted by this method is over comparatively short distances and at low voltages.

In the discussion of this subject the proper system to use is first taken up, showing the advantages of direct and of alternating current and where each will best apply. Then comes the consideration of how much loss is properly allowable in a transmission circuit, of the causes of such loss and of the proportioning of wire to give most economical results. Then the other provisions in a circuit for insulation, for control of the system, for supporting the circuit, for making connections to the main wires, for changing the voltage as may be needed at different points, together with the consideration of transformers both stationary and portable, and the protection of transmission lines against injury by lightning, by overload and by grounding.

More and more as power plants grow larger and the tendency increases to centralize power, transmission over longer or shorter distances becomes necessary. There is no use in trying to oppose this advance, for it is in line with the spirit of economy and good engineering. Power plant engineers must, therefore, be ready to meet these new conditions, and in the specialized January issue will be found just the knowledge which they will need. In every way it will be up to the standard of previous work done by those who are in charge of the Practical Engineer editorial department, and in no other publication can this information be found collected and put in form where it is so quickly and practically available for use.

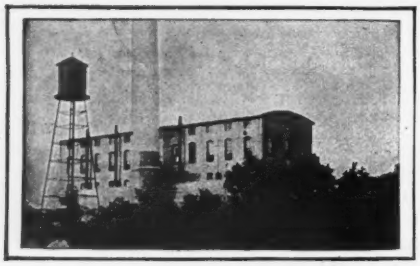
Are you wondering the cost of this great specialized issue, to you?

It will cost subscribers to Practical Engineer not one cent, for it is included in the year's subscription. It will cost any engineer 50 cents if he is not a subscriber.

Think what you get as a subscriber to Practical Engineer: 24 big issues, one each month for two years at $1.50, only, and two of them, the two January issues are specialized treatises on important power plant subjects.

If you subscribe today this will happen—first of all you get at once the November issue; then with hardly any wait the December number will come to you; and then, the tremendous January number full of information will be on hand a short time after. And so on during the two years. Where else could you get such a bargain. Two years for $1.50.

PRACTICAL ENGINEER, 355 Dearborn St., Chicago



Power Apparatus

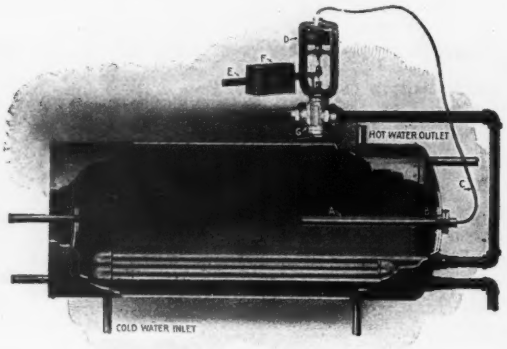
In Shop and Market

New Ideas in Making, Buying and Selling

IDEAL SYLPHON TANK REGULATOR

THE accompanying cut shows a new temperature regulator for hot water storage tanks by steam. The brass stem A screws into the storage tank through a 1¼-in. opening B in either the end or side of the storage tank. A small flexible brass tube C, 3/16 in. outside diameter and 8 ft. long, connects stem A with a metal bellows D, which operates the valve G controlling the flow of steam to the heating coil in the tank. This arrangement permits valve G to be installed at any desired point in the steam line.

Stem A, tube C, and bellows D are hermetically sealed, and confine a liquid which vaporizes at low temperatures. When the water in the tank becomes heated, vapor generated in stem A exerts a sufficient pressure to force some of the liquid through pipe C into bellows D, which expands the latter by overcoming counterpoise weights F and closes valve G, thereby preventing further admission of steam to the coil in the tank.



SYLPHON TANK REGULATOR

When the water in the tank cools slightly, some of the vapor in stem A condenses and allows liquid to flow from bellows D, through tube C back into stem A permitting the bellows to collapse and open valve G. By moving the weight F backward or forward the regulator is adjusted to operate at any desired temperature between 140 and 200 deg. F.

Its use is not confined to storage tanks, but extends to all liquids heated by steam. It has been used on pasteurizing machines, in breweries, sugar refineries, aquariums, sprinkler systems, laundries, etc.

The manufacturers claim extreme sensitiveness of action due to the great power quickly generated by the volatile liquid and to the flexibility of the metal bellows or diaphram. The outfit is completely selfcontained, requiring no auxiliary power and is made entirely of metal.

It is sold by the American Radiator Co., 282 Michigan Ave., Chicago, Ill.

PYRAMID DOUBLE-ACTING PISTON PUMP

RAPID extension of electric power circuits throughout towns, cities and in country districts, and the introduction of gas and gasoline engines, affords ideal power and opportunity to install economically a medium priced power pump for general water supply or other pumping duties.

To meet the demand for a compact horizontal double-acting power pump which would possess superior advantages in point of simplicity, durability and general efficiency over other pumps of this class,

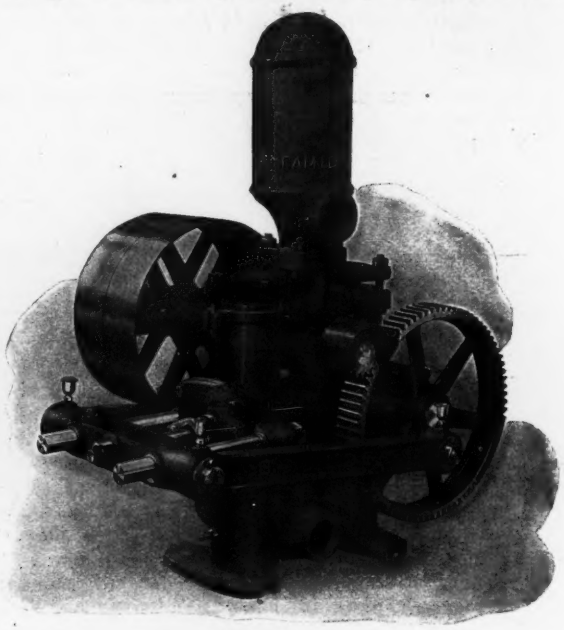


FIG. 1. GOULD'S "PYRAMID" DOUBLE-ACTING PISTON PUMP

The Goulds Manufacturing Co. of Seneca Falls, N. Y., has recently placed on the market The New Pyramid Double-Acting Piston Pump which is an evolution from its original pump of the same name but designed along similar lines. The waterways have been largely increased and made more direct; it is much more compact, its general construction much more rugged and its efficiency greatly increased.

Base, cylinder, bearings, and one cylinder head are cast integral, giving a remarkably stiff and rigid construction, and the one cylinder head being cast on the cylinder removes all possibility of leaking or blowing out packing at this point. Casting the bearings as a part of the cylinder keeps the gearing absolutely in

line, greatly decreasing the wear and proportionately increasing the life of the pump. The cylinder is brass lined, and is provided with large suction valves just below the bore of the cylinder, these valves being easily accessible through 2 handholes, the covers of which can be removed by backing off one bolt.

Discharge valves are above the cylinder and reached through handholes located at either side of the air chamber. To remove the handhole plates, it is simply necessary to loosen one bolt and slip it out of place, freeing the clamp holding the valve cover in position. With this construction there is no possibility of the valve cover caps rusting into position.

On the forward end of the cylinder are cast 2 substantial lugs, into which are pressed and secured by heavy nuts, 2 carefully machine-turned steel rods to act as a guide for the crosshead. This construction takes the lateral strain from the cylinder head and eliminates the tendency to work out cylinder head packing.

The front cylinder head is so machined as to have a large projection fitting into a corresponding recess in the cylinder, and as this projection is turned at the same time that the hole of the stuffing box gland is bored, the piston rod must run absolutely in line with the bore of the cylinder, eliminating cutting of the rod. The stuffing box on the cylinder head is provided with a bolted bronze gland, making it easy to keep the packing tight at this point. Side rods are heavy gray iron castings of the most substantial construction and are so designed as to give a straight line thrust from the crank pin to the crosshead.

On the power end, this pump consists of a pinion shaft supported on a long double bearing in the center of the pump directly under the air chamber, the construction of this bearing being such that no outboard bearing is required. The lower half of this pinion shaft bearing is made extremely long and is provided with an auxiliary cap at the outer end next to the pulleys which gives a second bearing for supporting the shaft. This cap is arranged with a large oil pocket which is readily filled by raising the cover between the main bearing and the auxiliary bearings, and oil from this reservoir is fed to the bearings by means of wicks, for months without oiling.

Both gear and pinion are cast iron, machined all over, with teeth cut from the solid metal insuring quiet operation and long life. The pump is geared 5 to 1. Cast on the rear end of the pump is the crank bearing, of ample size and provided with a large oil pocket and cap. Both crank and pinion shafts are of high carbon steel carefully finished all over. All bearings are lined with high grade bearing metal; the piston rod is of high carbon steel brass cased.

The Pyramid offers an ideal outfit where pumping of almost any kind is desired up to 75 lb. pressure or 175 ft. elevation, such as general water supply including tank pumping for farms, country estates, railroad water stations, irrigation, light, oils, kerosene, gasoline and spraying trees. Where a large and constant supply of water is necessary for the farm or country estate, the Pyramid can be profitably used, and small gas or gasoline engines or electric motors are recommended for driving.

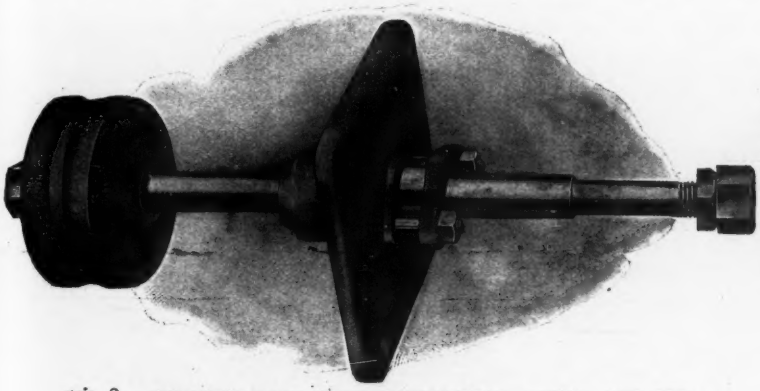


FIG. 2 CYLINDER HEAD WITH STUFFINGBOX, PISTON AND ROD

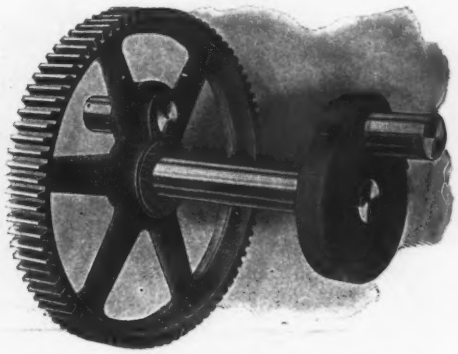


FIG. 3. DRIVING GEAR, SHAFT AND CRANK PLATE

THE LOXON LAMP GUARD

THE SAFE LAMP GUARD

ALMOST any lamp guard will protect a lamp from breakage if it is strongly made but the light-fingered can not only remove the lamp guard but also the lamp. In the Loxon Guard, safety is secured for both lamp and guard, not only from breakage but from theft. With this guard, which is made to open at the side, the outer end is closed so that there is no chance for breakage even by a direct thrust from the end, and furthermore the guard is attached to the lamp socket by a key screw which cannot be loosened with any ordinary tool.

Lamps cannot, therefore, be taken away for filling in the sockets at home or for selling to the second-hand dealer. Aside from its theft protection the breakage protection is superior to the open-ended guard. The Loxon is made by the McGill Mfg. Co., 33 Oak St., Valparaiso, Ind.

ABSOLUTE VENTILATION THE YEAR ROUND

THE Sirocco electric fan and air purifier is a device developed by the American Blower Co., Detriot, Mich., using a Sirocco standard turbine type impeller wheel but 3 in. in diameter as the basis for bringing the fan system of ventilation within the reach of everyone using electric current.

FIG. 1. THE SIROCCO FAN IN INSTALLATION

On account of the high efficiency of the Sirocco fan, the electric motor is only 1/7 hp. and the electric current requirement is almost insignificant. The office boy or stenographer can install the complete outfit upon the window sill without tools.

FIG. 2. ADAPTATION OF THE SIROCCO TO OFFICE VENTILATION

Sirocco will supply 5000 cu. ft. of fresh, filtered air every hour, diffusing it throughout the room or in any direction at will, or deflecting it through radiator for winter ventilation. By the simple reversal of a small lever, without changing the position of the outfit or stopping it, Sirocco will exhaust from the room the dead air in the same large volume. The complete outfit consists, in addition to the Sirocco fan and motor, of an adjustable outlet nozzle for summer use, speed controller, a dozen filter cloths, a window sash lock which prevents the window being raised from the exterior after the outfit is in place, and a rustless steel window filler adjustable to standard width sashes. The air supply is purer than the outer air because of its being filtered.

FREDERICK S. PALMER of the Strong Carlisle & Hammond Co., was recently in Chicago on business and favored the office with a call.

THE HAWKES BOILER

AS WILL be seen from the cuts shown herewith, this is a combination of water tube and fire tube constructions. Figure 1 shows the rear view of the boiler without covering, Fig. 2 the front view showing the connection of the tubes into the water leg, and Fig. 3 shows the boiler as arranged in its setting, the position of the grates and the flame travel. A tile roof furnace gives time for complete combustion and the travel of the flames between the 2 rows of tubes gives heating surface of great activity, which insures a rapid circulation. The long flame travel over the water tubes and through the tubular part of the boiler, gives ample time for the absorption of heat from the gases by the water and insures a good efficiency. The complete combustion in the tile roof furnace maintaining the gases at a high pressure until all the carbon has been consumed, makes provision for smokeless operation.

The top of this furnace is made of interlocking tile carried on the lower bank of tubes. These tile are massive blocks which hold the heat and as the space between the tubes is 6.5 in., there is plenty of tile material to keep

FIG. 1. REAR VIEW OF HAWKES BOILER WITHOUT COVERING

the gases hot, and it is possible to burn bituminous coal, crude oil or coal tar as fuel, without producing smoke.

Scale formation in the water tubes is prevented by the rapid circulation through them. These deposits are all carried up and left in the upper shell in the form of a soft mud, which can readily be blown out. As the fire does not reach the bottom of the shell, this deposit is not baked onto hot plates and, therefore, it never becomes a hard scale. The front view shows that each tube in the lower row is connected to an independent box header with a curved connection to the waterleg, so that there is independent expansion of each tube and no chance for bent or sagged tubes.

Connection areas between the legs and the upper shell are more than 100 per cent greater than the combined area of the tubes, so that tubes will be flooded under all conditions of firing and there will never be any tendency to hold back the water and permit bubbles of steam to form in the tubes.

Figure 3 shows only a small amount of foundation

and brickwork is needed in setting this boiler, since the shell and rear waterleg are carried entirely outside the brick casing. The manufacturers state that this brickwork is so arranged that no buck stays or tie rods are required and the boiler is left free to expand away from the brickwork without racking or cracking the walls.

As seen in Fig. 1, there is a handhole opposite each tube in the rear leg which can be reached from the outside, so that tubes can be removed from the boiler on either front or rear without taking down the brickwork or any part of the setting. The gases are all drawn from the front towards the rear so that the front of the boiler is kept cool, making firing comfortable.

As the action of the boiler is studied it will be noted that there are no riveted seams or joints hidden behind brick walls, where corrosion can take place, nor exposed to the hot gases, nor is the blow-off pipe exposed to hot

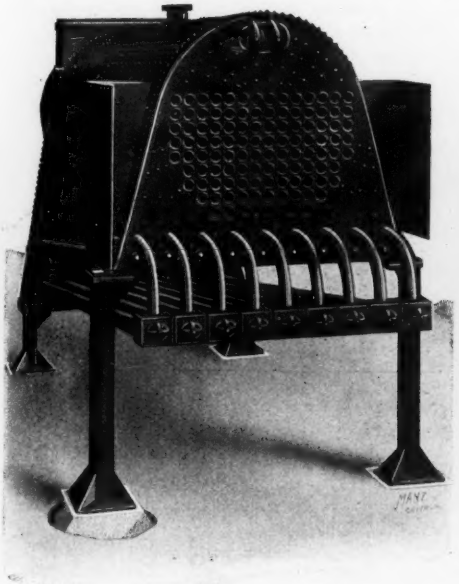


FIG. 2. SEPARATE BOX AND ARCH TUBE CONNECTIONS AT FRONT OF HAWKES BOILER

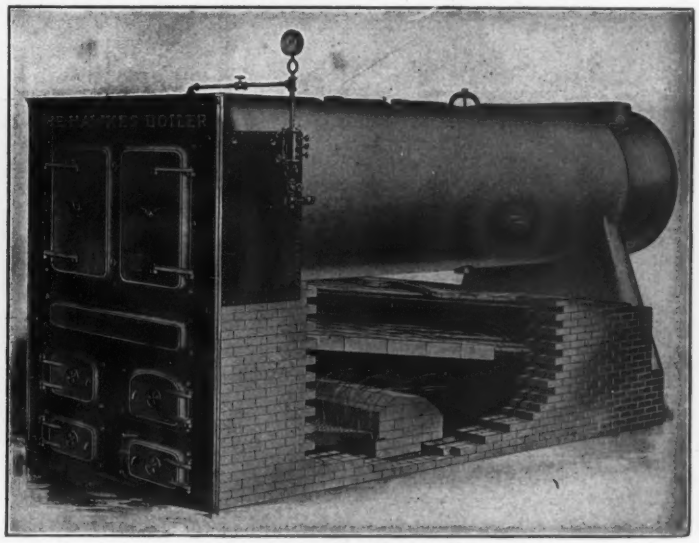


FIG. 3. HAWKES BOILER IN SETTING SHOWING TRAVEL OF GASES

gases. The heating surface in the water tubes gives high boiler power, so that the boiler occupies a small space and takes up little head room.

Performance speaks louder than promises, and 5 years' actual service, using water which in some cases was highly loaded with magnesia and lime solids, has shown that the water tubes did not need boring or cleaning. This is proved by letter from the Dredge Engineer of the United States Engineer's office in St. Paul, Minn., using Mississippi River water, and a letter from C. F. Gunther, of Chicago, using artesian well water full of magnesia and lime deposits, in both of which cases the tubes have kept free from objectionable scale and the boiler has been able to carry heavy overloads.

This boiler is made by the Hawkes Boiler Co., 204 Dearborn St., Chicago.

THE G. M. DAVIS REGULATOR CO., Chicago, has opened a sales office at 500 Bank of Commerce Building, Minneapolis, to care for its trade in the Northwest. T. B. Scambler, who has had a long experience in this territory and who was formerly with Warren Webster & Co., will manage the office.

LUBRICATION TESTS AT CRAMP & SONS' SHIP YARD

RECENTLY at the request of the Keystone Lubricating Co., of Philadelphia, a sample of Keystone Grease was tested in the laboratories of Wm. Cramp & Sons' Ship & Engine Building Co. on a Cornell oil testing machine. These tests covered a period of 1 hr. each at pressures of 2,000, 3,000, 4,000 and 5,000 lb., the area of the journal being 14 sq. in., so that at 5,000 lb. pressure the load per square inch was 357 lb.; the journal ran at 450 r.p.m. and was lubricated by grease fed from a hand pressure cup of about 3 oz. capacity. About 15 min. was allowed after each increase in pressure to let the temperature of the journal become constant.

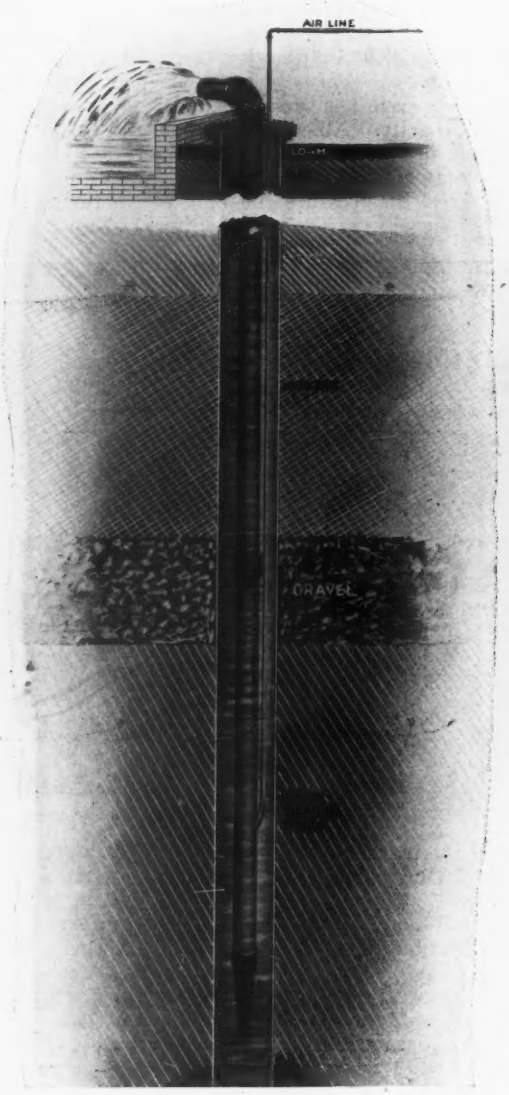
Under 2,000 lb. pressure the increase in temperature of the journal over the room ran from 77 up to 80 deg. F., averaging 79.1 deg., and the friction in pounds was 11.9, giving an average coefficient of friction of 0.00595. At 3,000 lb. the rise in temperature above that of the room was from 87 to 94 deg., averaging 91.1, the friction 16.4 lb. average, and the coefficient of friction was 0.00547. At 4,000 lb. the average increase of temperature was 95.7 deg., the average friction 15.3 lb. and the average coefficient 0.00333. At 5,000 lb. the average increase of temperature was 102.2 deg, the average friction 16.3 lb., the average coefficient 0.00326.

It is noticeable from the records of the test that in every case the friction in pounds decreased from the time of starting the test down to the time of stopping. During the entire run the grease maintained its original consistency under the heavy pressure and rate of speed at which the shaft was running, and after the test, neither shaft nor bearings showed any signs of being harmed in any way.

J. H. SIMONS, of Aurora, Minn., is at the present time engaged in the installation of a 3-phase 2200-volt alternating current system for amusement park enterprise and desires catalogs and descriptive matter on steam, water and electric supplies and specialties.

IMPROVED AIR LIFT WELLS

FOR many locations the air lift is the cheapest possible system of lifting water from deep wells. It is simple and not likely to get out of order, always ready to start and of good efficiency when properly proportioned. One difficulty in using the air lift has been to lift a solid column of water. The tendency



THE A. W. FRANCE AIR LIFT

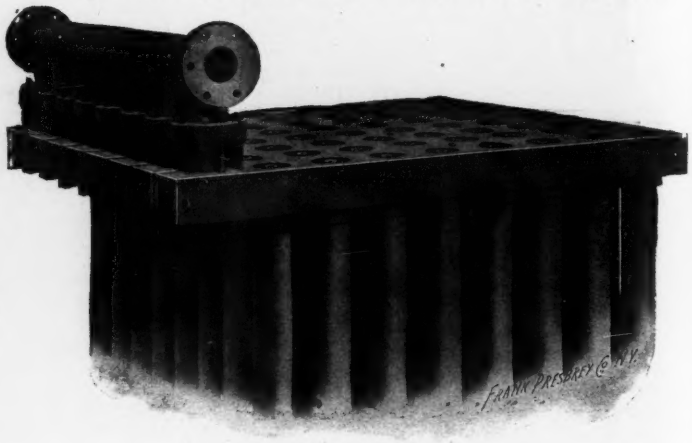
has been to throw the air into the water in the form of a spray which does not give efficient action.

In the air lift, made by A. W. France, of Tacony, Philadelphia, the air is thrown directly into the bottom of the rise pipe, as indicated in the illustration, and the water enters from all sides of the pipe and is carried upward by the air. It sprays the water into the air, therefore, instead of spraying the air into the water. The air is always under water and the makers guarantee that a compressor of comparatively small capacity will operate the system. They claim a saving of 35 to 50 per cent in the air needed and back up their claim with a guarantee that if it does not do this the well point will be taken back.

In sending for information in regard to an air lift pump the following data should be given: The number of feet from the surface of the ground to the water when not pumping, diameter of the well at different depths, total depth of the well in feet, how far above ground water is to be elevated. Can water be delivered at the surface and pumped to elevate it? Size of boiler and pressure it will carry. Horizontal distance from well to tank and from engine room to well. How many gallons of water to be pumped, size and speed of air compressor if one is already installed.

NEW HEADER USED ON GREEN ECONOMIZER

ON the whole, the fuel economizer still retains the form given to it by its original inventor, Edward Green, who in his original patent specifications issued in 1845 described not only the fundamental idea and the construction found most practicable, but most of the variations which have been



GREEN FUEL ECONOMIZER SECTIONS WITH EXTENDED TOP

proposed by later inventors as well. It is true that a few modifications, such as the use of internal instead of external lids, have been made to suit higher boiler pressures, but all other changes have been along the lines of making the economizer more reliable and accessible and reducing the cost of attendance and upkeep.

We illustrate herewith a new feature of this kind, lately introduced by The Green Fuel Economizer Co., of Matteawan, N. Y. The illustration shows the new extended top header. Formerly the openings in the top of each section header, through which the hot water flowed into the top branch pipe, were placed directly over the last row of tubes and were made large enough for the introduction of the lids. This construction, however, made it necessary when washing out the economizer tubes, either to leave the last row unwashed, or to remove the branch pipe in order to get at these tubes. Another construction often used on the Green economizer was to have the branch pipe fitted with handholes over each tube in the last row. This type was known as an access branch pipe.

In the design illustrated herewith the necessity of removing or opening the branch pipe has been done away with by extending the header out beyond the last row of tubes, thus making it possible to get at every pipe by the removal of the corresponding lid.

To permit of taking out the lids from the headers, one, called the master lid, is made larger than all the others, so that the others can be removed through the master hole. If it becomes necessary, for any reason, to remove the master lid from the header then the branch pipe can be taken off, the opening to the branch pipe being made large enough for the removal of the lid. The sides of these improved headers fit closely together, thereby making a gas tight joint. Where the extra width necessitated by this construction would be objectionable, the style header with an access branch pipe placed directly over the last row of tubes is supplied.

THE HAVARD COAL METER

THIS is a device designed for the purpose of measuring coal or other granular material. It consists of a rotating spiral vane positively geared to a resisting device, the vane element being inserted in the center of a chute through which the coal or other material is delivered.

By design, this chute is always maintained full of material so that the vane element is constantly immersed.

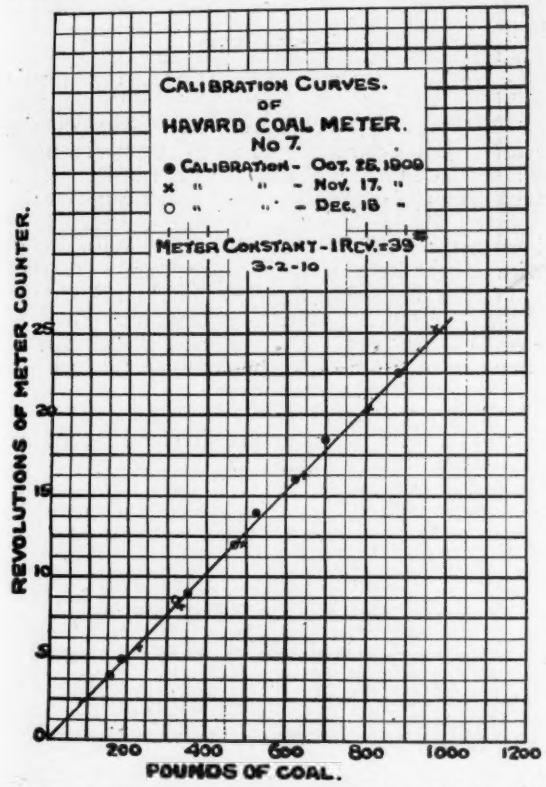


FIG. 2. CALIBRATION CURVES OF HAVARD METER SHOWING CONSTANCY OF WORKING

As material is withdrawn from the lower end, the downward motion of the full column of material in the chute causes a rotation of the spiral vane, which has been found to vary directly as the downward motion of material in chute, which in turn depends on the quantity withdrawn.

From the illustration it may be seen that the meter is of simple, yet rugged design. All parts coming in contact with material measured are made of bronze to withstand corrosive or rusting action. The gears and bearings run in a bath of oil which insures long life and little attention. To the external body of meter is attached a counter driven by the rotating vane through suitable gears and shafts. This counter may be made to read direct in pounds, tons, cubic feet or bushels, as may be desired. A calibration curve of one meter is shown. This meter is 1 of 14 which have been in constant service in front of 7 boilers for several months, and tests made on different dates covering a period of 2 months, show that it may be relied on for accurate and trustworthy readings.

The Havard Coal Meter has been in practical use for some time in 3 power stations, the L. & W. R. R. Co. at Scranton, the Scranton Electric Co. and the Wilkes-

FIG. 1. THE HAVARD METER AS MOUNTED AND REMOVED FROM CHUTE

Barre Gas & Electric Co. In these plants it is used to measure coal which in each case is small anthracite. The meters have been given little attention beyond the reading of the counter at stated periods, and are giving satisfaction in every way.

Other fields in which it would seem that this meter would prove most valuable, are the coal fields, the measurement of coal from breaker to boiler room, in private plants or residences to check quantity of coal delivered and in the grain and ore districts.

To show the great value in boiler room economies, we cite one instance at the Laurel Line whereby it was made possible to analyze the fuel consumption of various units under different conditions of rapidly fluctuating railway loads.

This meter was invented and patented by O. D. Havard, and is manufactured by the O. D. Havard Co. of Scranton, Pa.

WILLIAM A. TUCKER, secretary and treasurer of the H. A. Rogers Co., New York, celebrated the thirtieth year of his connection with that firm on October 18. Mr. Tucker, who is known as one of the most experienced credit men in the machinery supply trade, is the oldest officer and employe of the Rogers Co. in years of service.

STRONG CARLISLE & HAMMOND Co. of Cleveland, Ohio, has opened an office in Chicago at 564 Randolph St., which will be in charge of Charles Van De Velde. A full stock of 4/S specialties including traps, separators, reducing valves, pressure regulators and engine stops will be carried to supply the western trade.

NEWS NOTES

LEWIS INSTITUTE is opening its evening sessions and offers courses in engineering including principles and mathematics, electricity, steam and gas engines, and steel construction, the mechanic arts including drawing, woodworking, iron and steel working, forge and foundry practice; mathematics, including algebra, trigonometry, geometry; chemistry, including qualitative and quantitative analysis, and special courses in general subjects, such as languages, arts and crafts, accounting, etc. Full information in regard to any of these courses can be had by writing to the registrar, Lewis Institute, corner Robey and Madison Sts., Chicago.

OCT. 10-13 THE American Boiler Manufacturers' Association met at the Auditorium Hotel in Chicago and a program of meetings and entertainment was carried out which was the most successful in the history of the Association. In the meetings, which were nearly all executed, matters of policy in regard to standards, terms, etc., were considered, and Boston was selected for the place of the next annual meeting, while the former officers were re-elected. President, E. D. Meier, New York, N. Y.; secretary, J. D. Farasey, Cleveland, Ohio; treasurer, Jos. F. Wangler, St. Louis, Mo.; first vice-president, T. M. Rees, Pittsburg, Pa.; second vice-president, J. Don Smith, Charleston, S. C.; third vice-president, W. A. Brunner, Phillipsburg, N. J.; fourth vice-president, H. D. MacKinnon, Bay City, Mich.; fifth vice-president, M. A. Ryan, Duluth, Minn.

Evenings and part of the days of the convention were devoted to entertainment features. On Monday night an entertainment, reception and dance was given, on Tuesday night a theater party and on Wednesday the entire convention adjourned for a trip to the big works of the Illinois Steel Co. at Gary. Wednesday night was vaudeville evening and Thursday night the closing banquet was served. The entertainment features of the week, which included shopping tours, automobile trips and cards for the ladies, were furnished by the Supply Men's Association, of which W. O. Duntley, of the Chicago Pneumatic Tool Co., was president, J. T. Corbett, of Jos. T. Ryerson & Sons, vice president, W. H. S. Bateman, of Philadelphia, secretary, and H. B. Hare, of Cleveland, treasurer.

CATALOG NOTES

MOREHEAD CONDENSER TRAPS for vacuum and heating systems, made by the Morehead Mfg. Co., Detroit, Mich., are shown in detail and in application in a folder just received from the company. These are made in return, non-return and vacuum forms and may be used for draining pipes either under pressure or vacuum, and also in combination for feeding boilers.

THOSE INTERESTED IN HEATING SYSTEMS will find the descriptive matter sent out by the Rochester Vacuum Valve Co., of Rochester, N. Y., of great interest. This shows the application of Rochester vacuum valves to typical power and heating plants and how feed-water regulators, damper regulators, steam separators, oil separators, back pressure valves, vacuum valves and traps and lifting returns may be arranged to good advantage.

FRICTION AND SHAFTING ECONOMY is the topic of an interesting folder received from the Oneida Steel Pulley Co., Chicago. It tells about the Oneida Maxant Roller Shaft Bearing and shows how this accommodates itself always to the position and flexure of the shaft.

FOUR LABORERS INSTEAD OF THIRTY is the title of a neat folder just published by Pawling & Harnischfeger Co. of Milwaukee. The body of the folder is a description of the work that can be done with a traveling bridge equipped with hoisting apparatus, all the product of the Pawling & Harnischfeger Co.

THE INDUSTRIAL INSTRUMENT CO. in Bulletin 39 illustrates and describes its industrial dial type thermometers, pressure and recording gages and tachometers. These instruments are all in the most convenient form for use about the power plant.

NATIONAL MOTOR AND BELT DRIVEN air compressors are described in detail in a handsome publication just issued by the National Brake & Electric Co. of Milwaukee. These compressors are built to supply compressed air for all purposes where compressed air is used, in both stationary and portable types.

THREE SEGMENTS is the title of a story in 3 chapters told by the Universal Flexible Packing Co., Pittsburg, Pa., in an interesting booklet describing its Flexible Metallic Packing.

SCHOOL OF ENGINEERING, Milwaukee, Wis., is offering courses in electricians' work, electrical engineering, mechanical drawing, mathematics and chemistry. The method of teaching and the costs of courses are shown in a school catalog, a book of 30 pages.

INTERESTING DATA from tests made on the Rice & Sargent Corliss engine as to steam consumptions and friction losses are contained in Bulletin S 77 received from the Providence Engineering Works, Providence, R. I. These tests were conducted on engines at the U. S. Military Academy, West Point, American Sugar Refining Co., Brooklyn, and at the Bureau of Engraving & Printing, Washington, D. C., and were made by such eminent authorities as Geo. H. Barrus, of Boston, and D. S. Jacobus, at the time of the Stevens Institute of Technology, so that the results are beyond question correct.

The data are in regard to compound condensing and non-condensing engines and simple non-condensing, and show steam consumptions as low as 18 1-3 lb. per indicated horsepower per hour on a non-condensing engine at 150 lb. initial pressure and with an efficiency of 79.2 per cent as compared with the possible performance of the steam engine.

On compound condensing engines at the same pressure the steam consumption ran as low as 12.1 lb. and for the non-condensing simple at 149 lb. initial pressure the steam consumption was 20.98 lb. Mechanical efficiency ran as high as 98.5 per cent. The bulletin contains interesting tables of results in such form as to be convenient for comparison with the performance of other engines, and can be had direct from the Providence Engineering Works.

WAINWRIGHT EXPANSION JOINTS made by the Alberger Condenser Co., are fully described and illustrated in Catalog No. 11. This shows how such expansion joints are used and gives a full list of sizes, dimensions and capacities. These joints are made in low-pressure form for exhaust mains and in high-pressure form for steam and water mains.

ZIERMORE REGULATORS in different styles for pumps, gas and oil fuel lines, draft systems, steam lines, boiler feed pump lines, heating lines, boiler feed water lines, are described in a series of pamphlets issud by the Ziermore Regulator Co., of Johnsonburg, Pa. All these devices are controlled by metal bellows

arranged with pressure either inside or outside, as may be required and operate without packing or stuffing boxes. They can be set while in operation, are extremely sensitive and practically indestructible. The details, methods of operation and prices are given in the bulletins.

"POWER FOR CEMENT MILLS FROM WASTE HEAT" is the title of a booklet recently published by The Green Fuel Economizer Co., of Matteawan, N. Y. After presenting information regarding the amounts of fuel used in the various cement-making processes, it points out that a large per cent of the heat developed is wasted up the kiln stacks and boiler stacks, or radiated by the hot clinker. It then discusses several means of cutting down these wastes. The methods described include the use of an economizer in the kiln flue, combination of a boiler and economizer using the waste heat from the kilns and a method in which both a boiler and an economizer are used to absorb the waste heat, with a supplementary coal burning grate. A method is also described for preserving the heat which is usually wasted by hot clinker. These various methods of conserving the heat are illustrated by photographs and lay-outs of actual installations in cement mills. The same methods, with slight modifications, possibly, should be applicable in other industries where heat is wasted in considerable quantities, as from reheating furnaces, crucible furnaces, etc. Copies of this bulletin can be had by addressing The Green Fuel Economizer Co.

FORT WAYNE ELECTRIC WORKS has recently issued Bulletins 1121, 1124 and 1125. Bulletin 1121 describes and illustrates in detail Northern Type B direct current generators. These are made in all sizes up to 75 kw. and possess all the superior points characteristic to the Wood Systems. Bulletin 1124 brings out the advantages of Type K M-2 portable watthour meter calibrators for use on alternating currents, showing and explaining the operation and construction. Bulletin 1125 is a description of Type K_3 single-phase induction watthour meter.

WHAT STOKER is the question asked in a folder received from the American Ship Windlass Co., of Providence, R. I. It discusses the over-feed the under-feed and the Taylor, showing the points in which the latter combines features found in the other two types.

TWO FOLDERS FROM THE OHIO BRASS CO. are of unusual interest to engineers who have the problem of reducing pressures in their plants. One of these, entitled Common Practice and Its Error, shows why regulating valves fail to satisfy and where the error is in the common practice of installing such valves. A chart is given by which the correct size of regulating valve to reduce from any high pressure to any low pressure may be found without the use of equations. The difficulty from using a valve that is too large is fully explained. Another circular from the Ohio Brass Co. shows in detail the interesting construction of the Ohio regulating valve, how perfect adjustment for reduction of pressure is obtained and how simplicity and durability are secured. The folders can be had by writing to the Ohio Brass Co. direct, at Mansfield, Ohio.

BULLETIN 4753 on the subject of Mazda 400 and 500-watt incandescent lamps for standard lighting service has just been issued by the General Electric Co., describing large Mazda lamps for standard lighting service. These lamps are suitable for large stores, armories, factories, etc., and are economical substitutes for other building units of high candlepower and clusters of small lamps of low candlepower. The bulletin contains data regarding cost of lamps and service at various voltages, and illustrates also the fixtures suitable for use in connection with these lamps.

TRADE NOTES

THE CLEVELAND ELECTRIC ILLUMINATING CO. of Cleveland, Ohio, has placed a contract with Tate, Jones & Co., Inc., of Pittsburg, Pa., for equipping 8 of the large boilers in its Clarkwood Road Power House with auxiliary oil burning equipment for use in connection with its regular coal fire for increasing the boiler output to take care of the peak load. Mr. Wolff, the chief engineer, figures that this will save the purchase of 4 boilers.

DANGER TO THE EYES is avoided by equipping with Swartwout Safety Automatic water gages. If the glass cracks, the valves close instantly, preventing the escape of steam and the consequent flying glass.

YORK MANUFACTURING CO., York, Pa., made the following important sales during the month of September: Wm. Esser, Spokane, Wash., 1 11-ton refrigerating plant for City Market; Reading Abattoir Co., Reading Pa., 1 65-ton compression side, brine coolers and piping for new abattoir; Consolidated Ice & Power Co., Valdosta, Ga., 1 11-ton refrigerating plant; Delaware Ice & Light Co., Selbyville, Del., 1 20-ton ice making plant; Geo. A. Fuller & Co., 1 30-ton refrigerating plant for the Whitehall Annex Building, New York City; The Schumacher Co., Houston, Texas, 1 8-ton refrigerating plant for grocery; Great Falls Meat Co., Great Falls, Mont., 1 20-ton compression side and expansion piping for meat depot; Chas. F. Sheffer, Dewart, Pa., 1 10-ton refrigerating plant for creamery; Wilson Creamery Co., Huntington, W. Va., 1 40-ton compression side, brine coolers and piping for ice cream factory; Percy Fur House, Oshkosh, Wis., 1 6-ton refrigerating plant; Henry Meyer, Brooklyn, N. Y., 1 240-ton complete ice making plant; John Treber, Deadwood, S. D., 1 8-ton ice making plant; McSweeney Packing Co., Sweetwater, Texas, 1 65-ton compression side, 10-ton freezing system, and expansion piping for abattoir; Althoff Manufacturing Co., Denver, Colo., 1 30-ton compression side to be installed at the Western Packing Co.'s plant, Denver, Colo.; Eastman Kodak Co., Rochester, N. Y., 1 400-ton high-pressure side; Riverton Ice & Cold Storage Company, Riverton, N. Y., 1 20-ton compression side, 12-ton freezing system and brine piping for storage house; Crystal Springs Ice Co., Cincinnati, Ohio, 1 150-ton high-pressure side.

THE FOLLOWING COMPANIES HAVE recently sent repeat orders for Taylor Stokers to the manufacturers, The American Ship Windlass Co., of Providence, R. I.: Solvay Process Co., Detroit, Mich.; Cleveland Railway Co., Cleveland, Ohio; Wardlow Thomas Paper Co., Middletown, Conn.; Ohio Street Railway, Quincy Point, Mass.

SWARTWOUT OIL AND STEAM SEPARATORS, made by the Ohio Blower Co., of Cleveland, Ohio, have recently been purchased by: Syracuse Twist Drill Co., Syracuse, N. Y.; Girard Iron Co., Girard, Ohio; Agnes Scott College, Decatur, Ga.; N. K. Fairbanks Soap Co., Chicago, Ill.; Cadillac Veneer Co., Cadillac, Mich.; The Moundridge Milling Co., Moundridge, Kan.; Ebbitt House, Washington, D. C.; Acme Wire Co., New Haven, Conn.; Bastian Brothers Co., Rochester, N. Y.; The Bingham Co., Cleveland, Ohio.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—By young man, 21 years of age, as fireman, oiler, or any position around a power plant. East preferred. Box. 155 Practical Engineer, Chicago, Ill. 11-1

POSITION WANTED as engineer in a small plant, or as hoisting engineer. Have had several years' experience. Position in South preferred. Address Box 96, Quitman, Miss. 11-1

POSITION WANTED—Engineer with Philadelphia license and 10 years' experience, partly machine shop, can take full charge or act as assistant. Am finishing summer engagement. Address Walter S. Griscom, Buck Hill Falls, Pa. 11-1

POSITION WANTED—By steam and electrical engineer. 30 years of age, married, sober and reliable. Have an A. S. of C. education. Am at present master mechanic for electric railroad. Good references. Address Box. 154 Practical Engineer, Chicago, Ill. 11-1

Help Wanted

WANTED—LIVE, HUSTLING SALESMAN to call on engineers to sell a widely advertised oil filter. Good commissions. Address Box 152, Practical Engineer, Chicago, Ill 10-2

WANTED—AN ENGINEER in each town to sell the best metallic packing for steam, air, gas and ammonia. Write Ideal Metallic Packing Co., South Stillwater, Minn. 5-tf

WE HAVE a stunning proposition for an engineer in every town or city. Little time required. Will not interfere with regular work. Write for particulars. Address Box 136, Practical Engineer. 8-tf

WANTED—SALESMEN TO HANDLE as a side line staple articles of more than usual merit, exceedingly attractive and duplicate orders follow; only those acquainted with steam appliances need apply. A. W. Holbrook, Palmer, Mass. 11-1

WANTED SALESMAN—Calling on power plants and factories where belting is used, to sell guaranteed Pulley Wheel Facing; eliminating all belt dressings; saves from 10 to 35 per cent in power. Virgin territory is open for live agents. Argo Supply Co., 136 Liberty St., New York, N. Y. 10-2

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

WANTED—THE SERVICES of a representative in Illinois, Indiana and Wisconsin, to look after our old customers and prospective buyers of our Modern Simple Tax-free Industrial Alcohol Distilling Apparatus, by special successful demonstrative methods for making Alcohol, Apple Jack, Aguardiente, Mescal, Teguila, Peach Brandy, Solidified Alcohol in Cubes, Pine Oil, Turpentine, Essential Oil, Etc., also Denatured Alcohol. Most modern simple 5 Gal. Still and all Sizes to 500 Gal. daily Capacities. Good salary and commission. Address with three references. The Wood Waste Distilleries Co., Inc., Wheeling, W. Va., U. S. A. 11-6

WANTED—SALESMAN—Calling on plants using steam for power, to carry an easy selling article as a side line. Can be carried in pocket. Good commission. Address Box 151, Practical Engineer, Chicago, Ill. 10-2

Wanted

YOUR SUBSCRIPTION EXTENDED—We will extend your subscription, giving you two months' credit for the return of your September copy of Practical Engineer and if you desire it, will forward reprint of slide rule article which appeared in that issue. Simply write your name and address on wrapper and forward it to Practical Engineer, 355 Dearborn St., Chicago, Ill. Copies should be in good condition and received before Nov. 15. 10-2

For Sale

FOR SALE—SOME GOOD BARGAINS in water wheels; send for our list. Calvert Bros., Poughkeepsie, N. Y. 11-1

FOR SALE—75 H. P. OLDS GAS ENGINE—For natural gas or producer gas; also 80 H. P. Pintsch gas producer; all in perfect condition and will be sold cheap. United Sash and Door Co., Wichita, Kans. 11-2

FOR SALE—100 H. P. Smith's automatic suction gas producer, 25 H. P. gas engine, 12 H. P. gasoline engine, 8x8 Gardner air compressor, and several large and small storage tanks. Monroe Light & Fuel Co., Monroe, Wis. 11-1

FOR SALE—$1.50 WILL BUY CASTINGS and all material for a neatly designed modern automatic steam engine. Engine has governor and slide valve on cut off principle with adjustment for wear. Blue prints and instruction sheets 25c. Pat. Novelty Co., Box 193, Elgin, Ill. 11-1

FOR SALE—THREE RETURN TUBULAR Boilers, manufactured by Ritter Bros., Buffalo, N. Y. Drums 72 in. by 116 ft. Each Boiler with sixty-six 4 inch Tubes. Inspected by Travelers Indemnity Co. of Hartford, Conn. 93 lbs steam pressure Boilers in good condition. Can be delivered in two or three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y. 8-6

Patents and Patent Attorneys

FREE BOOKLET—All about patents and their cost. Shepherd & Campbell, Patent Attorneys, 500 M. Victor Bldg., Washington, D. C. 5-tf

HAVE YOU AN IDEA?—Write for our books. "Why Patents Pay," "100 Mechanical Movements," Perpetual Motions—50 illustrations. Mailed free. F. Dietrich & Co., Patent Lawyers, 64 Oray Block, Washington, D. C. 4-tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for inventors sent upon request, 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

"TELEPHONE TROUBLES" AND HOW to find them, and manual of costs units, New Edition, (14th). Price 25c. W. H. Hyde, 183 5th St., Milwaukee, Wis. 11-1

EVERY ENGINEER should know about the new system of Vacuum Heating, which can be installed without payment of royalty. Particulars will be cheerfully furnished. T. L. Reeder, 1413 W. Jackson Blvd., Chicago.

Educational

LEARN WIRELESS & R. R. TELEGRAPHY! Shortage of fully 10,000 operators on account of 8-hour law and extensive "wireless" developments. We operate under direct supervision of Telegraph Officials and positively place all students, when qualified. Write for catalogue. Nat'l Telegraph Inst., Cincinnatti, Philadelphia, Memphis, Davenport, Ia., Columbia, S. C., Portland, Ore. 10-2